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West Europe Report

SCIENCE AND TECHNOLOGY

No. 64

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CONTENTS

TRANSPORTATION

ELECTRONICS

RESEARCHERS BUILD MICROCOMPUTERIZED SPEECH SYNTHESIZER

Stockholm DAGENS NYHETER in Swedish 11 May 81 p 10

> [Text] The machine is little bigger than a portable typewriter. On the upper side is an ordinary keyboard. If you write, e.g., DAGENS NYHETER and press the "fullstop" key, the machine says "DAGENS NYHETER!" in a mechanical but quite intelligible voice.

The machine is a speech synthesizer constructed by Björn Granström and Rolf Carlson at the Institute for Speech Transmission of the Technical University of Stockholm, where research has been carried on in problems of analysis and synthesis of human speech for decades.

The machine is full of modern microelectronics. The actual sound in the little loudspeaker is produced by "synthesizer" technology. So-called tone generators are responsible for the various voiced sounds, e.g. vowels, and sibilants such as f, s, and sh. The important "coloring" of the tones ("ö" does not sound like "a" or "i" even if they are sung on the same tone) is taken care of by electronic filters, and consonants can be formed by letting the sound escape in short pulses.

Generators, filters, etc. are controlled electrically by pulses from the computer. If these come in the right sequence and with the right distribution, intelligible speech is produced.

Talking Machines

Talking machines, such as electronic chess players, sound heads, and games, generally have simple generators that are controlled by a stream of pulses from permanent "memories" in the machine. Each time a pulse stream is emitted from a memory the same stream of sound is produced--word or sentence.

In such apparatus the text is fixed once and for all and the pulse stream is adjusted for the best possible reproduction of precisely that text. But when one attempts to convert variable text, from a keyboard, a punched tape, or a reading device, into spoken language, one begins to see what a dreadful numbskull a computer really is, measured in human terms.

Half of the microcomputer space in Granström and Carlson's speech synthesizer is taken up with memory, with rules of grammar and pronunciation--and exceptions to the rules. For the computer must be constantly instructed on matters that we people seldom think of, e.g. that if a vowel is followed by two consonants, as a rule it is short.

Different "K's"

And who knew that "k" in "kille" is really an entirely different sound from "k" in "kossa"? But the computer is sensitive to the difference. Therefore, when the text is fed into it--that can be done via the keyboard, from another computer, a telecommunications circuit, an optical text reader, or special equipment for the handicapped--the machine stores the first word or line of text and examines it as a whole before deciding what pronunciation (pulses to the speech unit) is right.

The development work has gone on for years and has resulted in a unique linguistic programming language that makes it easy to introduce knew findings about changed relationships between text and speech.

It has therefore been possible to develop complete programs for text-to-speech conversion of Swedish, German, English, and Spanish.

"English is hard," says Björn Granström. "It is an old, much altered language, with many differences between writing and pronunciation. On the other hand, Finnish is easy, as the text is more phonetic."

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CSO: 3102/272

R&D ACTIVITIES IN REGENERATIVE ENERGY SOURCES REVIEWED

Duesseldorf BWK: BRENNSTOFF-WAERME-KRAFT in German Apr 81 pp 138-145

[Article by M. Meliss, Juelich: "Renewable Energy Sources"]

[Text] 1. Significance of Renewable Energy Sources for the FRG

Technical restrictions, but especially ecologic and economic factors are drastically restricting the potential of renewable energy sources for the FRG (1). By the year 2000, in the most favorable circumstances, one can only expect the primary energy amounts, given in Table 1, coming to about $50 \cdot 10^6$ t SKE (hard-coal units) ($14.1 \cdot 10^{17}$ J) (2). Assuming a primary energy consumption, for the year 2000, amounting to $500 \cdot 10^6$ t SKE, that corresponds to about 10 percent of the coverage contribution. To reach that goal, considerably faster introduction speeds of renewable energy technologies into the country's energy markets are necessary--considerably faster than indicated today by events on the market. It was not only Federal Chancellor H. Schmidt in his 24 November 1980 government declaration (3) but also the industry concerned--in this case primarily the solar industry--who maintained that they are optimistic; by 1990, they expect the market volume for the various sectors of solar energy (4) as shown in Table 2. Considering a possible export of photothermal and photoelectric systems as well as wind-power plants, we get a total market volume of about $DM110 \cdot 10^9$, which means that we can preserve or newly create about 280,000 jobs.

Table 1. Primary Energy Substitution Potential of Renewable Energy Sources Under the Most Favorable Prerequisites in 2000 (Primary Energy Requirement: $500 \cdot 10^6$ t SKE)

	10^{17}J	10^6t SKE	%
Heat-pump systems	8.8	30.0	6
Solar panels	1.2	4.1	0.8
Water power	2.3	7.8	1.6
Wind energy converters	0.9	3.1	0.6
Biomass	0.9	3.1	0.6
No major contribution from geothermal powerplants and solar cell generators			
Total contribution	14.1	48.1	9.6

Table 2. Market Volume and Jobs for Various Sectors of Solar Energy

	Flat Panels	Photothermal powerplants, photoelectric powerplants, windpowerplants	Heat pumps, heat absorbers
Market volume by end 1979 (estimated in DM10^9)	0.1	1	1
Market volume, 1980-1990 (forecast in DM10^9)	1	3 to 5	100
Preservation or creation of jobs, 1980-1990	3,000	30,000	250,000

The overwhelming market share here would seem to be accounted for by heat-pump systems and combinations made up of heat pumps plus absorbers or collectors [panels]. Figuring on an investment volume of between DM25,000 and DM40,000 per system, we have at any rate $2.5\text{-}4 \cdot 10^6$ systems corresponding to that market volume. If we have constant annual sales increments, we would thus have to sell between 250,000 and 400,000 heat pump systems per year. The contribution of the panel [flat-collector] systems on the other hand looks rather modest here by comparison. If we have a system pricetag of between DM8,000 and DM10,000 (restriction of collector systems to hot-water preparation), we would have to sell only 10,000-12,500 systems per year.

The controversy of the panel system vs the absorber/collector-heat-pump combination, which last year was conducted partly in a rather vehement fashion, will not be revived at this point. Both systems are making their specific contributions to our heat supply (5-7).

A similarly superfluous discussion of competition aspects involving alternate heating systems was partly also conducted regarding heat pumps and the power-heat combination. Here again it must be kept in mind that the general national economic goal can be achieved most efficiently not through confrontation between but through cooperation among the two technologies, that is, the saving of valuable fossil fuels (8).

If we want to attain the primary energy substitution potential given in Table 1, then the market volume mentioned in (4) for the year 1990 must even be exceeded. The way to achieve that goal is certainly not simple and is connected with consequences regarding the entire energy supply for the FRG. The RWE (Rhenish-Westphalian Electricity Works, Inc.) (9) figured out the extreme case: If, out of the total heat-pump and heat-pump combination systems operated in 1990, $4 \cdot 10^6$ were to be driven by electric motors and were to be operated in the single-purpose mode, then we would need about 24 GW power plant output. That would correspond roughly to 20 powerplant blocks of the size of Biblis or roughly one-third of the total powerplant capacity currently installed in the FRG. This shows that in practice we can consider only double-purpose operation (normal operation with current, peak-load operation with oil or gas) where the powerplant capacity for the use of the same number of heat pumps ($4 \cdot 10^6$) need not be expanded. A reduction of the energy supply problem is further to be achieved through technological developments (gas-operated or diesel-operated heat pump, absorption heat pump) and requires corresponding R&D expenditures.

Quite obviously however the fact remains that the "soft" renewable energy technologies, which can be used in the FRG, require electric current to a considerable extent and that can come only from the "hard" central powerplants. The disputes (10-14), which on this topic likewise were partly rather vehement last year, seem out of place in view of the existing energy situation. Nuclear energy and solar energy are not alternatives that exclude itself mutually but rather they are options which are available to us to solve the energy problem and both of them must assume their own place in the energy supply system. In order to be able to attain the above-mentioned contributions of renewable energy sources to the energy supply in the FRG, we furthermore need to step up our efforts in the R&D sector. This is becoming increasingly difficult in view of the growing financing difficulties in Bonn. For 1981, DM2.33·10^9 have been earmarked for the energy research and energy technology sector (15). The main points in this priority research sector consist of coal research and technology and nuclear waste disposal. In the area of renewable energy technologies, we must expect a reduction in public research funds (16).

Here, the number of requests for research promotion keeps increasing constantly. PLE (energy research project management), which handles research also in the field of renewable energy sources for the BMFT [Federal Ministry of Research and Technology], in its 1979 annual report (17) shows the total costs for 1979-1980 to be DM641·10^6, as we can see in Table 3. Research projects in the renewable energy source sector are subsidized on the average with 72 percent government research funds. In 1979, these subsidies came to a total of about DM150·10^6. Related to the 1980 BMFT expenditures for the energy research and technology sector, amounting to DM2.2·10^9, that comes to about 7 percent. Related to the total public energy sector expenditures (18), that share on the other hand comes only to 2 percent. Only the future will tell whether these amounts are enough actually to achieve the nevertheless relatively ambitious substitution potentials for renewable energy sources in the FRG.

Table 3. BMFT Promotion of Renewable Energy Sources in 1979

1 Sachgebiet	2 Gesamtkosten*) 1977 - 1980 10^6 DM	3 mittlerer Fördersatz %	4 Zuwendung 1979 10^6 DM
5 Sonnenenergie			
6 Thermische Nutzung	92	58	30
7 Elektrische Nutzung	130	86	60
8 Biologische und Chemische Nutzung	1	88	–
9 Kombinierte Anlagen	24	100	16
10 Übergreifende Maßnahmen	10	96	3
11 Insgesamt Sonnenenergie	257	89	109
12 Windenergie	131	83	18
13 Geothermische Energie	177	36	*
14 Sonstige regenerative Energiequellen	33	51	2
15 Wärmepumpen**)	43	68	14
16 Summe	641	72	150

Key: 1--subject area; 2--total costs (*); 3--average promotion rate; 4--subsidies; 5--solar energy; 6--thermal use; 7--electrical use; 8--biological and chemical use; 9--combined plants; 10--overlapping measures; 11--total solar energy; 12--wind energy; 13--geothermal energy; 14--miscellaneous renewable energy sources; 15--heat pumps (**); 16--sum; (*)--partly including projects with a longer running time than 1980; (**)--1979 estimated subsidy not separately shown in PLE annual report.

2. Passive Systems, Low-Temperature Collector Systems, and Heat Pumps

The solar industry in the FRG in the meantime has become a well-established factor in our economic activities. The emphasis here is still in the area of supplying low-temperature heat for hot-water preparation and heating. But we have more and more projects in the application area of small consumers, agriculture, and industrial processing heat in the spread below 200° C. The number of fairs, exhibits, symposiums, and workshops on the topic of solar energy has gone into several dozens. Along with the flood of information on efficient energy use measures in the household sector, potential users of such technologies have a wealth of offers which cannot even be surveyed any longer and which cannot even be compared to each other. This increasing uncertainty among the consumers can be stopped only by establishing quality standards facilitating a technology comparison. Initial steps in that direction have already been undertaken (19). But there are as yet no breakthroughs in norming and standardization, especially regarding performance evaluation.

The Third International Solar Forum presented a good overview of the technological status, the results of current demonstration projects, and the publicly promoted research undertakings through a comprehensive exhibit and the status seminars sponsored by the BMFT/PLE on solar and wind energy use (20, 21).

Regarding passive solar energy utilization, here again the FRG is definitely behind other countries. Out of the total of 16 lectures delivered on that topic during that conference, more than half came from the United States alone. The few German contributions mostly were addressed to the question as to whether passive solar energy and extremely stepped-up heat insulation will mutually cancel each other out. For example, it was reported in one study (22) that architectural measures with a solar energy view in mind can no longer noticeably reduce the heat energy requirement when we have air-tight buildings with a high degree of heat insulation and with controlled ventilation. Even for buildings with little insulation, the savings effect deriving from passive solar energy utilization with the help of simulation computations has been estimated at 35 percent, at best. On the other hand, in (23) and in other studies, it has been asserted that passive solar energy use, naturally connected with corresponding heat insulation, under certain circumstances could make the use of mineral energy generation sources in the residential sector completely superfluous--certainly of course not in the West German climate region. Here again, higher savings than the previously-mentioned 35 percent can probably be achieved. A mathematical example from Austria proves that savings of 60 percent can be achieved also in Central Europe (24).

In the area of collector systems, it would seem that around 13,000 systems were installed in the FRG at the end of 1980. Last year there were no more recent market surveys on this group of topics. Most of the plants were used for hot-water preparation and/or indoor swimming pool heating. In spite of increased sales figures, these systems did not get to be much cheaper. A utility water plant for a single-family home, inhabited by between three and four persons, in other words, about 6-10 m^2 of collector surface, a 400-500-lit boiler, plus regulating devices and installation consts, will still have a pricetag of around DM10,000 and therefore continues to be uneconomical according to strictly operations-management viewpoints. The operational performance of small household systems is overwhelmingly satisfactory (25, 26).

Looking at large systems for hot-water supply, there is one project which gives us a good insight; it was tackled at the end of 1980 in the context of the ZIP (Future Investment Program); about 45 of the solar systems, financed with ZIP funds, in the sector of the West German Armed Forces are equipped with measurement instruments from a central agency and are uniformly compared with the help of data obtained. The lessons learned during the observation project which is still running and which involves eight West German Armed Forces installations that were placed in operation in 1979, are being fed into that project. This system is a so-called large-scale system with collector surfaces of up to 300 m^2 and storage volumes of up to 15 m^3. Some of the systems revealed defects which in particular were due to design layouts and regulating components that were not optimum or that were not adapted to the particular actual consumption (27, 28). These defects are basically easily corrected and are from the very beginning being avoided by establishing a central agency for solar technology in connection with the systems to be newly erected. On top of that we have the fact that the share of heat-pump combinations predominates in the systems to be newly built.

The year 1980 brought a definite boom on the heat-pump market. That is especially due to the fact that these heat pumps can be used in many different ways. Particularly favorable conditions result when both the hot and the cold sides can be used, such as this is partly possible for instance in case of combined operation of an ice-skating rink and an indoor swimming pool.

The electrically-powered heat pumps currently predominate in the range of smaller heat performance figures. Heat pumps driven by combustion motors predominate in the case of higher heat performance figures (amounting to around 110 kw). The absorption heat pump is still in the testing stage and has not reached maturity for market sales either in the small or in the large heat output range.

On the basis of systems sold and installed during the first quarter we can estimate that a total output of about 50,000 systems was attained in 1980, with systems featuring a heat output of up to about 2 kw (hot-water heat pumps) would seem to have held a share of about 50 percent (29, 30). The approximately 22 German manufacturers of heat pumps believe that they will be able to sell another 130,000 heat pumps in 1981 and in 1985 the figure is even supposed to go up to 300,000 per year.

A market study on hot-water heat pumps shows an offer of about 30 systems of that kind (31). The heat output here ranges from 1 kw up to 5.7 kw and the pertinent connection output is between 0.36 and 1.38 kw. The systems are mostly directly connected with hot-water boilers which have a volume of 250-600 lit. The final sales price, including the VAT, varies between DM3,000 and almost DM7,000.

The BMFT promotes the further exploration and development of heat pumps through about 40 projects. Research promotion is handled via the Energy Research Program Management within the context of the "Efficient Energy Use" program (32).

Interest in the heat-pump market moreover also focused on combined systems consisting of heat pumps and absorbers or collectors. These systems are offered for sale on the market under such designations as "Energy Roof," "Energy Facade," "Energy Stack," "Energy Fence," "Energy Column," or "Energy Sphere." The fact that utilization

possibilities, operational safety, and economy in such systems are still disputed today was pointed up last but not least also by the German-American conference on technology and use of electrical heat pumps in Duesseldorf (33). Lessons learned with an experimental house in Kulmbach (34) during the 1979-1980 heating season show that, in this climate zone (-18° C), single-purpose operation with the help of a roof absorber is impossible. At any rate, it was possible to meet about 78 percent of the heating heat requirement. The annual operating index for the heat pump was between 2.5 and 3.0. The house had two roof absorber devices: a copper roof covering about 98 m^2 and a synthetic pipe-grill roof of 83.5 m^2. Only the additional use of a varied heat exchanger made it possible to meet 100 percent of the heating heat requirements. The investment costs for such a heating system are correspondingly high. The Federal Association of the Heating, Air Conditioning, and Sanitary Equipment industry groups came up with investment costs between DM45,000 and DM50,000. The market survey prepared by the CCI gave figures of DM22-150/m^2 for integrated solutions and DM80-400/m^2 for so-called all-roof solutions (35). In making any price comparisons we must note that some manufacturers relate the prices to the surface whereas others relate them to the heat exchange surface.

Reasonably priced solutions could be found in more compact environmental air-heat exchangers for heat-pump heating. The RWE on that score among other things conducted investigations regarding the so-called energy stack (36). Such energy stockpiles can accommodate a heat exchanger surface of 50 m^2 on a ground surface of about 2 m^2. Initial operating experiences were gathered in a duplex (23 kw heat output) during the winter of 1979-1980. For operation during the cold season between December 1979 and March 1980, inclusive, a share of 29,700 kwh of utilized environmental energy was obtained and that corresponds to an oil equivalent of almost 3,000 lit. Nothing can as yet be said regarding the economy of such systems.

Low-temperature-collector systems, heat pumps, or combinations of both of these types of systems are being used increasingly also in the sector of small-scale consumers and in industry as well as agriculture (37). The emphasis in development here is on air collectors. In the autumn of last year, a solar vehicle lacquering plant [paint shop] was placed in operation in Neumarkt. It was to heat the necessary fresh air for the system to 24° C in the injection cabin and to 65° C in the drying cabin as shown in Figure 1. The system's manufacturer expects amortization already within 3 years, considering depreciation and investment subsidy (38).

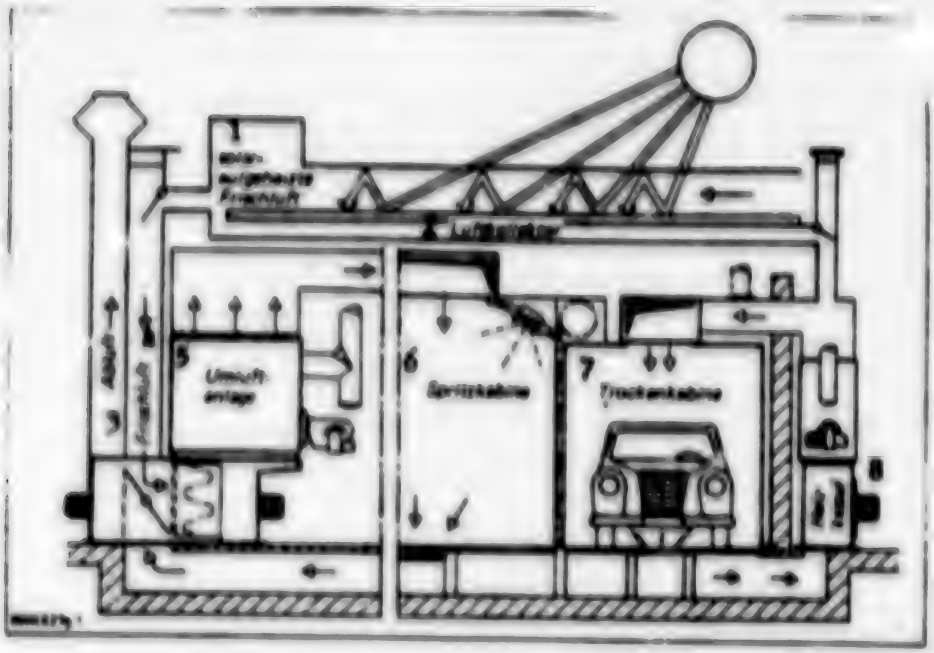

Figure 1. Solar vehicle paint shop (38). Key: 1--solar-heated fresh air; 2--air collector; 3--waste air; 4--fresh air; 5--air recirculation plant; 6--spray cabin; 7--drying cabin; 8--boiler.

While highly-efficient air collectors are required for the above-mentioned purpose, the development of air collectors for agricultural drying processes or use in developing countries which have much sunshine is especially aimed at simple and cheap collectors. Investigations in this field showed that it should be basically possible to make air collectors with very little material requirement (DM5-20/m^2 in the case of foil collectors) (39).

3. High-Temperature Collector Systems and Solar Cells

Research work in the field of solar-thermal powerplants progressed in 1980. The solar farm plant in Getafe, Madrid, made jointly by MAN [Augsburg-Nuernberg Machine Factory, Inc] and AUXINI, began operating in 1980. The system, designed for generating processing heat, can turn out 250 kw of thermal output (300° C). Employment for conversion into about 36 kw of electrical energy is possible (40). The system has three different collector designs with a total surface of 580 m^2 and an energy storage unit with a capacity of 36 m^3. For conversion of thermal energy into mechanical energy, we have a water-steam power machine on the basis of a screw compressor which, in this performance range, compared to turbines and piston-steam motors reveals a higher efficiency, simpler design, and better performance under partial load.

The "Eurelios" power plant is a solar-tower powerplant which is being built by the three EC countries FRG, France, and Italy in Adrano, about 40 km from Catania (Sicily, Italy). In addition to the above-mentioned countries, the EC Commission itself takes care of 50 percent of the total project costs which come to about DM25·10^6. Eurelios has a designed electrical output capacity of 1 Mw which is generated with the help of 182 heliostats (total reflector surface 6,216 m^2) and a "receiver" attached to a 55-m high tower (41, 42). Table 4 shows the technical data for the system which is supposed to become operational with network feed early in 1981.

Table 4. "Eurelios" Technical Parameters

System type and marginal conditions
Experimental system with central radiation receiver
Location: 37.6° N, 14.8° E (Adrano, Catania, Sicily)
Design point: equality between day and night, noon, assumed irradiation [insolation] 1,000 tu/m^2

Main characteristics
Nominal output (electrical): 1 Mw
Thermal output at receiver: 4.8 Mw
Reflector surface, total: 6,216 m^2

Heliostat field
Heliostats: two types, extended along two axes
CETHEL type: about 52 m^2, eight focusing modules, 70 heliostats
MBB [Messerschmitt-Boelkow-Blohm] type: about 23 m^2, 16 focusing square elements, and 112 heliostats

Receiver/tower
Vacuum receiver: opening diameter 4.5 m, at a height of 55 m, inclination 110°
Water vapor at receiver outlet: 512° C 64 atm abs, 4,860 kg/hr

Steam cycle
Turbine connected with receiver, no heat exchanger in between
Nominal output: 1,200 kw (mechanical) with steam of 510° C, 60 atm abs
Feed water temperature at receiver inlet: 36° C
Cooling water temperature: 25° C, maximum

Thermal storage units
For operation at reduced output for 30 minutes
Storage agents: water/steam 300 kwh, salt (Hitec) 60 kwh
Pressurized water tank (19 bars) for 4,300 kg, steam with 19 bars to 7 bars
Salt storage unit: two tanks for a total of 1,600 kg Hitec
Heat exchanger for 19 bars, 480° C and 410° C steam

Electrical system
AC generator for a minimum of 1,100 kw
External output 100 kw, consumption inside system 100 kw
Transformers, emergency power for pumps, connection to network; switches, transformer, etc.
To be operated centrally from control room: steam cycle control, regulating units for powerplant subsystems.

The 100-kw (electrical output) MBB powerplant in Kuwait (43) is also about to be completed; here, the individual farm modules do not consist of parabolic grooves, as in the case of Getafe, but rather of paraboloid collectors. Table 5 shows the system design data. The decisive factor in system design here is the thermodynamic circuit process with an organic working medium (toluene)(66).

Table 5. Design Data for Solar Farm System With Electrical Output of 100 kw, Kuwait (Paraboloid Collectors)

Design	Day: 21 March 1200 insolation 0.94 kw/m^2	
Performance data	Solar	1,000 kw
	Thermal	731 kw
	Generator output	137*) 164**) kw
	Useful output	100*) 120**) kw
Collector field	56 collector paraboloids	
	Opening surface	1,064 m^2
	Concentration factor	210
	Energy source medium	Thermal oil (Diphyl)
	Energy storage capacity	100 kwh
Energy conversion	Type	ORC
	Working medium	Toluene
	Generator drive	Turbine
	Cooling	Air or water
System efficiency	Solar/thermal	73.1%
	Thermal/generator output	18.8*) 22.4**)%
	Useful output	10*) 12**)%

Key: (*) air cooling; (**) water cooling.

At the "Plata Forma Solar" construction site near Almeria on the Costa del Sol, Spain, the cornerstone was laid on 17 January 1980 for both of the 500-kw powerplants of the IEA. Belgium, the FRG, Greece, Italy, Austria, Sweden, Switzerland, Spain, and the United States are participating (44). Just a few steps away, the Spaniards, under their own control and management, erected their CESA-I project (Almeria Electric Powerplant). This is likewise a solar-tower powerplant, although this time with a designed capacity of 1.2 Mw which, in contrast to the IEA project, will work with a water-vapor process; 300 heliostats with a surface of 40 m^2, each, will concentrate sunlight on the top of an approximately 60-m high and round concrete tower.

All systems share the fact in common that they can be used basically only in countries with high direct sunlight and here they will certainly have to compete against photovoltaic power plants, at least in the small output range (solar-farm systems). Questions of economy however will be further discussed only on the basis of actual operational experience.

An important criterion in addition to economy is the question of the net energy balance sheet of such power plants. A more recent study proves that the time, during which such a power plant has reproduced the energy required for construction and operation over its entire lifetime, is about 2 years in the case of solar-farm systems in the output range of 1 Mw and only about 1 year for solar-tower systems in the

output range of about 100 Mw. For the sake of comparison we might mention the fact here that these time figures for a coal-fired power plant of 100 Mw are about 0.15 year, with 1,300 Mw about 0.08 year, and in the case of a nuclear power plant of 1,300 Mw around 0.33 year (44a). Compared to these figures, the energy amortization time of current generation plants using flat or slightly concentrating collectors (in the 10-kw range) appears completely hopeless; it is almost 9 years (45).

In the area of solar cell generator development, interest is still concentrated on the accelerated reduction of construction costs of the cells, in other words, the central subsystem of photovoltaic generators. The building blocks must, depending upon the purpose, be assembled into complete systems and must be tested in suitable pilot plants. In addition to decentralized plants in the field of telecommunication, refrigeration, air conditioning, drinking water preparation and processing, their use in the area of integrated energy supply systems (solar villages) is increasingly emphasized. Figure 2 (46) shows the current development level of current generating costs for such systems and at the same time indicates the future development goal of the AEG [General Electric Corporation].

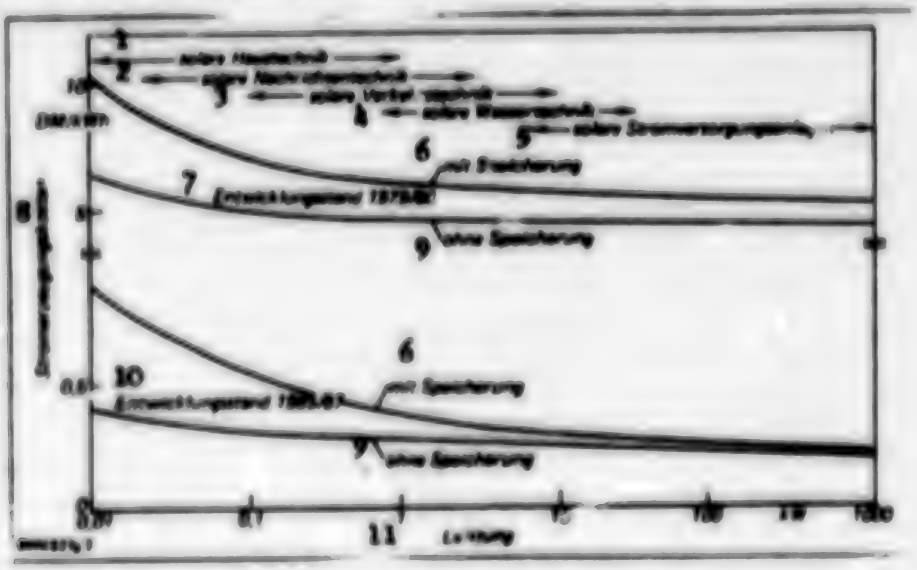

Figure 2. Current Generating Costs for Voltaic Solar Systems, Development Level and Goal (46). Key: 1--solar household equipment; 2--solar communications equipment; 3--solar transportation equipment; 4--solar water equipment; 5--solar power supply systems; 6--with storage; 7--1979-1980 development level; 8--current generating costs; 9--no storage; 10--1985-1987 development level; 11--output.

Whether the ambitious future plans shown in Figure 2 can be really carried out depends on the solution of a series of different questions. A good overview on this subject and regarding the international status of solar research was provided by the Photovoltaic Energy Conference of 1980 in Cannes (47). The specialized lectures and discussions there demonstrated that research and development of solar cells in the FRG, when compared to the leading nations, the United States and heavily committed France, must still be stepped up considerably. The accompanying exhibit showed a large number of complete systems for solar current generation. It is interesting to note

that the electronics industry companies which so far have been leading in this sector are being increasingly displaced by petroleum corporations and their corresponding affiliates. This development is obviously speeded up by the high expectations connected with the possible export market for solar cells (48). A study prepared by the Department of Energy shows a worldwide demand for electrical power output, by 2000, amounting to about 1,400 Mw. With investment costs of DM1-5/w, this, in the year 2000 alone, would correspond to a market volume of about DM2-7·10^9.

The possibilities of improving the economy of the solar cell generators are not exclusively confined to improvements in the silicon cell production process. In addition to the search for other semiconductor materials (for example, amporphous silicon, cadmium sulfide), there are also possibilities of concentration, both of the direct and the diffuse radiation share. Such developments are also being investigated intensively in the FRG (49).

The attempt at improving the availability and thus the economy of solar cell power plants through the installation of such systems in outer space (SSPS--Solar Satellite Power Station) can certainly be termed an extreme case of such possibilities (50).

In addition to the above-mentioned research and development work, the question as to how solar cell generators in the more distant future can contribute to the broad-scale technical solution of the world's energy problem is increasingly under discussion. Here we are particularly thinking of the use of hydrogen (51, 52).

4. Wind Energy Converters

In the area of wind energy utilization, the emphasis of attention in the FRG is on large-scale systems in the Megawatt range. The BMFT today promotes about 25 projects with a financial volume of more than DM100·10^6 (53). Growian I, with its two, 50-m long wings, each, and an output of 3 Mw, is under construction along Kaiser-Wilhelm-Koog [reclaimed land] near Brunsbuettel (54). Parallel to that, planning work is being pushed for Growian II, the single-wing large-scale wind energy converter in the electrical power output range of more than 5 Mw (55, 55a).

In planning the construction of a demonstration plant for an upwind power plant, the FRG has entered virgin territory which so far has not been further investigated worldwide (56). Figure 3 shows a view of this plant which consists of the combination of a collector system with a wind turbine. The system's overall efficiency will be around 1 percent so that the question of possible economy must be doubted rather seriously.

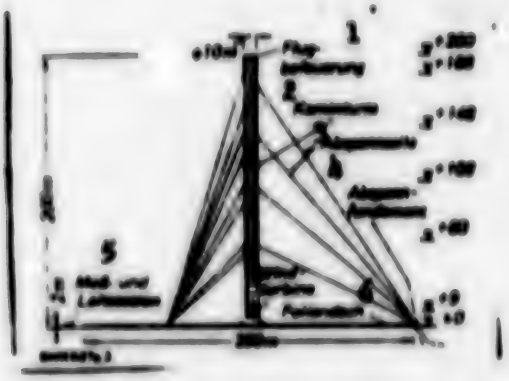

Figure 3. Demonstration System for Upwind Power Plant With Electrical Power Output of 100 kw (56). Key: 1—flue furnace; 2—chimney tower; 3—guy wires; 4—foundation; 5—measurement and control station; 6—sheet roof.

The second major point in investigations in the area of wind converters involves small systems in the kilowatt range which can be used for water pumping, current generation for remote users, or heating purposes (57). Here, the lessons learned in connection with various research and demonstration projects, especially the "Pellworm" project (58), show that many detail questions remain yet to be cleared up in order to increase the technical availability and especially the economy of such systems. It is especially the utilization possibilities of such systems in the less industrialized parts of the world that are an incentive for stepped-up R&D efforts along those lines.

5. Possibilities of Using Other Energy Sources

To explore the utilization possibilities of geothermal energy in the FRG—which in all probability will remain confined to the preparation of hot water—the federal government in 1979 spent about DM7·10^6. About DM64·10^6 in subsidies are included in the budget for the period of 1977-1980. The undertakings are designed to pursue geothermal prospecting and exploration, to use new prospecting methods, and to investigate the effects of the possible utilization of geothermal energy. The FRG cooperates closely in this field both with the EC and with the IEA (Paris). Interest here is concentrated on the further utilization of the Hot Dry Rock method (59, 60).

Wave energy in the FRG will never be able to make a noteworthy contribution to energy supply. Nevertheless, in view of international activities in this field, voices are being heard again and again, urging a stronger commitment in research and development. The West German government of course does not see any specific points of departure for this kind of work (61) especially for large-scale plants. The use of wave energy is being analyzed intensively especially in countries with long coastlines and a correspondingly high theoretical potential. The IEA countries Japan, the United States, Canada, Great Britain, and Ireland for example, through the Japanese Kamei project, are investigating the possibility of implementing wave energy conversion in mobile plants (ships).

The FRG is not pursuing any projects of its own also in the area of ocean heat utilization because the oceanographic possibilities are not present. The hitherto

positive operational experiences with the "Mini-OTEC" system, which since August 1980 is being operated off Hawaii on a sidelined American navy tanker, however lead us to expect a further increase in worldwide efforts to use ocean heat. Here, the FRG can be active as supplier and developer.

Among the other possibilities of using renewable energy in the FRG, it was especially bioconversion which was discussed in 1980. Table 6 once again gives us an overview of the basic conversion possibilities of biomass into energy sources (62, 63). The biophotolytic processes are still in the basic research stage. Both thermochemical and biological processes for the utilization of biomass can basically also be used in the FRG. So far only the combustion method is being used on a priority basis. In 1978, the share of firewood out of the FRG's primary energy consumption was less than 0.2 percent (64). For this purpose, $1.8 \cdot 10^6$ m^3 of timber were used as firewood primarily in rural regions. Following the conference on "Heating With Wood" (65), which was held early in 1980, the utilization possibilities of wood as energy source in the FRG were evaluated partly very optimistically. But even if we were to use the total timber cutting volume in the FRG (just about $30 \cdot 10^6$ m^3) exclusively for energy purposes, we could not even meet 3 percent of the primary energy requirement. Wood as a primary energy source will remain confined to special utilization areas in agriculture or in forested regions, last but not least for reasons of cost, and will possibly be able to increase its primary energy consumption to about 0.6 percent.

Table 6. Methods and Efficiency of Bioconversion

Process	Products	Overall Efficiency
(I) Thermochemical Processes		
Combustion	Heat, Steam	65-80%
Gasification, partial oxidation	Lean gas (4-7.5 MJ/m^3)	
	Middle gas (11.5-15 MJ/m)	55-85%
Pyrolysis	Gas (10-15 MJ/m^3),	75-80% total
	Oil (23-30 MJ/kg),	
	Coke (20-30 MJ/kg)	40-45% for oil
Direct liquefaction		
Reduction	Oil (30-40 MJ/kg)	$<$ 58%
Hydration	Oils, gases	?
Liquefaction through synthesis		
Methanol	Methanol (19.7 MJ/kg)	48%
Fischer-Tropsch	Hydrocarbons (40-45 MJ/kg)	$<$ 40%
Ammonia	NH_3 (14.2 MJ/m^{3}18.4 MJ/kg)	-
(II) Biological Processes		
Ethanol fermentation	Ethanol (26.8 MJ/kg)	10-79%
Biogas fermentation	Biogas (20-25 MJ/m^3)	50%
Rotting	Heat	$\approx$ 50%
(III) Biophotolysis		
Microorganisms	H_2 (10.8 MJ/m^3)	0.4% today, 3% ?
Artificial dyestuff membranes	H_2 (current)	75% (H_2)?

The increased use of the other methods listed in Table 6 in the FRG likewise cannot be expected on short notice. These conversion methods are not yet ready or economical at least on a large-scale industrial basis. They must be further developed especially regarding the procedural technology, the biomass supply and pretreatment and product utilization, whereby we above all can expect problems connected with a considerable enlargement in the plants. Worldwide, in addition to combustion, only the two fermentation methods leading to biogas and ethanol would seem to make a contribution to energy supply in the future. Gasification, including pyrolysis into only gaseous and solid products, will increase in significance in medium-range terms while the other methods mentioned, if at all, can become ready for the market only in very long-range terms.

The R&D efforts in this field should be stepped up in the FRG in spite of the limited utilization possibilities.

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5058
CSO: 3102/296

ENERGY

FIRST BIG ORDER FOR WIND POWER PLANTS SEEN AS BREAKTHROUGH

Stockholm NY TEKNIK in Swedish 9 Apr 81 p 3

[Article by Mikael Holmstrom: "Breakthrough for Karlskronavarvet: Wind Power Plant to the South Pacific"]

[Text] Karlskronavarvet--Svenska Varv has obtained the first big wind power order in the world. Together with its American cooperating partner, Hamilton Standard, the shipyard is to deliver 20 power plants to Hawaii.

According to what NY TEKNIK has been told, the shipyard will also participate in the newly-formed power company as a part owner. The breakthrough means that other big deals are already being discussed.

Since August 1980, it has been evident that Karlskronavarvet and Hamilton, working together, had eliminated their competitors, Boeing Engineering and Westinghouse (NY TEKNIK NO 34, 1980).

On the other hand, the "letter of intent" which was to confirm the deal had not made its appearance--that is, not until now. Now the combined companies are moving ahead.

"There were a number of reasons for the delay; this is a new technique, and everybody involved was very cautious in relation to the others," says Wayne Van Dyck, the managing director of the American firm, Windfarms Ltd.

Windfarms is a private company which drew up the contract with the power company in Hawaii. The power company undertook to buy all the electricity Windfarms produces for 25 years for at least 6 cents per kilowatt hour. In turn, Windfarms solicited offers from producers of large wind power plants and worked on financing the installation. A total of $350 million (1.6 billion kronor) is required.

Investments Are Large

Hamilton Standard and Karlskronavarvet, working together, got the contract because they were the ones who were willing to put up the most financial guarantees. Hamilton's self-confident wind-power outlay is described on pages 62 and 63. In addition to Karlskronavarvet/Svenska Varv, Hamilton also is cooperating with the engineering firm of Bechtel International and the First Boston Corporation investment company. This deal is the first wind power order which does not involve

government money, and it is very complicated. But first we will give the technical data: 20 power plants, each with a power of 4 MW, will be built on Kahuku Point on the island of Oahu, the main island of Hawaii. Their annual production of 430 million kilowatt hours of energy will cover 8.5 percent of the annual electricity requirements.

The power plant is identical with the plant that is being built in Maglarp in Skane. The engine buildings are being produced by Svenska Varv for slightly more than 200 million kronor.

The company is faced with a tough delivery schedule. The first engine buildings will be shipped from Sweden next summer. The last will be shipped in 1984--one per month. The first connection with the power network will be accomplished in the spring of 1983, Windfarms states. Windfarms very recently received an increment of oil capital.

"This first commercial project provides us with tremendous possibilities for competing and also constitutes a breakthrough in our immediate environment. First we will deliver 6 power plants. After that, we will pause for 6 months, and then we will complete another 14. We will also have a chance to improve our technique considerably while making those deliveries," says Doctor of Technology Anders Brannstrom, who is the chief of development for the Svenska Varv concern.

Like a Rolling Snowball

Developments have come like a rolling snowball for the shipyard. In 1977, the agreement to cooperate with Hamilton was made; in April 1978, Swedish wind research workers specified its wind power plant as acceptable; in June 1979, orders were received for delivery in Sweden (Maglarp Skane); and in January 1980, orders were received from the United States Department of the Interior. And now, although it has not yet completed a single engine building, orders have been received for 20 more.

"We are aware that there are many risks," says Anders Brannstrom, " but as soon as we had obtained the Hawaiian order there was not much reason to hesitate any longer. The only thing to do is to step on the gas and move ahead--we can gain a tremendous advantage both technically and with respect to the market.

"It is a new technique," he says, "and we are going to run into problems. What we must do now is to see to it that we are properly prepared to deal with them."

Built-In Safety Nets

"If one tumbles to the ground, one gets hurt," says Brannstrom, "but we already have some safety nets built into our contract work."

To demonstrate that the suppliers have confidence in their technique (so that other investors will become interested), Windfarms compelled the suppliers to become shareholders in the enterprise which is to run the installations.

The total amount is approximately $100 million. However, Svenska Varv only needs to contribute approximately $10 million (45 million kronor).

The remainder of the entire program of financing the project--involving approximately $200 million--will be accomplished by having the First Boston Corporation go to certain private investors to obtain the money. In the United States, such investors can count on a 25 percent tax rebate on the funds invested in energy alternatives.

NY TEKNIK has learned that the Hamilton-Svenska Varv-Windfarms combination is now discussing other orders of various kinds. They are concerned with California and Oregon. These various projects are both smaller and considerably larger than the contract for 20 power plants which has already been concluded.

9266
CSO: 3102/280

FRENCH TO EXPLOIT SPANISH SOLAR ENERGY STORAGE METHOD

Madrid EL PAIS in Spanish 2 Jun 81 p 39

[Article by Manuel Toharia]

[Text] Commercialization of a Spanish invention that could mean savings of up to 30 percent of the national petroleum bill is under imminent risk of falling into the hands of a French multinational company; there has been no state or private financial support for the chemical solar collector discovered by Dr Francisco Soriano, an industrial engineer.

Francisco Soriano's invention was patented exactly 1 year and 3 months ago. Called Abs collector, it is a system that makes it possible to collect solar energy at a very low temperature, store it for a desired period of time and release it at a much higher temperature.

According to the Spanish inventor, the central idea behind his system is the principle of balanced chemical reactions. By forcing this chemical balance through the introduction of heat obtained from the sun, a greater production of one of the compounds resulting from the reaction is obtained and can be stored. When, later on (at night, during cloudy days, in winter), it becomes necessary to recover the energy thus stored, it is enough to trigger the chemical reaction in the opposite direction through a catalyst, releasing energy in the form of heat.

This idea of using chemical energy to store solar energy is not new; the really important element in Francisco Soriano's invention is that he found a chemical reaction that needs low-temperature heat to upset the balance. This makes it possible to use very inexpensive solar collectors (panels) because it is no longer necessary for the water to be over 40 degrees, for example, and in contrast, at the moment of recovering the energy thus stored, because the reverse reaction is very exothermic, temperatures above 100 degrees can be reached. Consequently, the system generates thermal yields that are three times as large as usual and is like a heat pump that obtains thermal energy from a cold body, and releases it through a chemical

change. In short, the collecting system is charged at a low temperature and, in contrast, is discharged at the desired moment at a very high temperature, with all the concomitant advantages.

Worldwide Commercialization

Yesterday the inventor told EL PAIS that the Abs system is close to being sold to a multinational company in the energy field with headquarters in France. This company will commercialize the invention throughout the world, except in Spain and Latin America. Francisco Soriano said: "Even though we received substantial offers from important foreign companies, we have not sold the patent because we want the invention to remain Spanish. The contract we are about to sign with the French deals only with worldwide commercialization of the invention."

For Francisco Soriano, who is a government employee, the support received from official Spanish institutions has been disappointing. "In contrast, the French and Japanese experts we contacted in view of the difficulties that kept arising in dealing with official Spanish organizations were excited with the idea and, after a detailed study of several months, came to the conclusion that this is something really important in the field of solar energy storage, which is the most difficult aspect of the solar energy field. The Japanese wanted to buy the patent from us," the Spanish inventor stated, "but the French offered to take care of commercializing the invention in the world, except in those countries we would indicate, and we are going to close the deal with them. It is regrettable that the advantages derived from a 100-percent-Spanish invention will benefit a foreign country because of the obstinacy of a group of bureaucrats and the foresightlessness of Spanish businessmen in the sector."

9341
CSO: 3102/302

MODEL OF NEW TYPE OF COAL GASIFICATION PLANT EXHIBITED

Duesseldorf VDI NACHRICHTEN in German 24 Apr 81 p 9

[Article by sg: "Model of a Saarberg Internal Reciprocating Combustion Gasification Plant in Hanover"]

[Text] The high-temperature gasification method makes it possible, with mixtures of oxygen, air, and water vapor as gasification agent, to achieve the complete conversion of mineral fuels into gases which are used, after corresponding processing, as hydrogen, synthesis gas, gas for burning, or reduction gas. Due to the operation of the reactor under pressure, we achieve an essential increase in the reactor performance and, in case of further gas utilization, we achieve a reduction in the compression costs. The specific investment costs for gas generation and gas processing are lower in connection with pressurized systems.

Using the Saarberg-Otto coal pressure gasification method, we can gasify practically all types of coal. The method is used for the simultaneous gasification of solids and liquid fuels, for example, hydration residues. Conversion is complete and we get no tar or condensable byproducts.

The nucleus of the system is the Saarberg-Otto carburetor which operates according to the high-temperature-flue-current principle. The three-phase suspension carburetor [gasifier] is a cylindrical shaft which, in the area along the bottom, is covered with a liquid slag layer. Fuels and gasification agents are blown in through a nozzle system which is aimed in a tangential manner at the slag bath. This causes the slag bath to perform a rotating motion. The surplus slag flows through a central drainage pipe and is granulated in the water bath. Above the melting chamber phases we have a follow-up gasification stage in which the carbon and the gasification agents continue to react. In the cooling stage, in the reactor's upper part, the gas temperature is reduced by mixing in cooling gas and liquid slag components are solidified. The plant, which is shown in the model, has been working since the end of 1979 at the Saarberg Technology Center at Voelklingen; this is a demonstration plant built by the Saarberg/Dr C. Otto team. The plant is designed for a coal processing rate of 10.5 t/hr with a gasifier [carburetor] pressure of 25 bars and is among the biggest of its kind in the world. The experimental program for the next several months consists in running the plant at varying pressure stages and loads and determining the particular characteristic data and performance limits. Plans also call for determining the performance of the plant and the optimum operating procedures when various fuels are used. The Federal Research Ministry shares in the total financing costs to the extent of 75 percent.

5058

CSO: 3102/296

BRIEFS

COUNCIL FUNDS GEOTHERMAL R & D--A number of research workers all over Europe are concerned with geothermal energy. Now that the first 4 years of successful research and development have been completed, the Council of Europe has decided to continue that work. That applies now, first of all, to geological investigation of selected areas, the development of techniques and work with heat from dry rocks. In all, approximately 85 million kronor are being invested in the second project. One of the applications in this field which is more frequently discussed is the utilization of geothermal energy to heat approximately 20,000 residences in Paris. That obviously encouraged them to continue the research. [Text] [Stockholm NY TEKNIK in Swedish 9 Apr 81 p 11] 9266

CSO: 3102/280

SURVEY OF ROBOTICS IN NUCLEAR INDUSTRY

Paris REVUE GENERALE NUCLEAIRE in French Jan-Feb 81, pp 6, 8-12

[Excerpt] On 24 June 1980, at Saclay, the French Nuclear Energy Society arranged an information day on the theme: "From remote handling to robotics." Messrs Vertut and Coiffet contributed by presenting the descriptions and analyses which are continued and developed in the following articles.

By Jean Vertut, head of the Technical Agency for Protection and Dosimetric Equipment, Department of Protection, Institute of Protection and Nuclear Safety.

From the remote handling of the mechanical master-slave arm to advanced remote operation supported by computers, the author presents the principal accomplishments which have marked the development of robotics during recent years and describes their applications in the nuclear field.

Introduction

The rather barbaric term of robotics has, in recent years, come to encompass areas already known and presents, at the same time, new prospects.

We actually use robotics without knowing it, as Monsieur Jourdain did with prose... Remote handling, beginning with the mechanical master-slave arm of hot laboratories (some 15,000 exist worldwide, of which a thousand were built in France), which "reaches" three meters, now attains the unlimited ranges of the master-slave handlers with electronic servo-controls.

A pair of mobile remote handlers moving in a laboratory or a workshop replaces a man to a much greater degree than handlers in a fixed position (comparable to the gloves in a glove box): thus, the concept of the "remote operator," which is the projection over distance in a hostile environment of an operator who remains sheltered in his comfortable command post, appeared around 1970. From that point, there easily occurs an evolution toward "the robot," when (fig. 1) one goes from the permanent presence of a man in the command loop toward assistance by a computer associated with more and more numerous sensors, and, next, when there is a tendency toward growing autonomy in decisionmaking and plan generation by computers.

This "remote operation," part of "robotics," is now a subject of interest for any industry which might be involved in operations in a hostile environment, nuclear, traditional industries, petroleum, undersea, or space, and there is a special relevance for maintenance operations (and particularly inspections).

One of the first robots "Virgule" (Radio Guided Intervention Vehicle Useable in the Laboratory and Outside), built at the AEC [Atomic Energy Commission] and of which the prototype is about to become a museum piece, is the source of the current development of studies in the complex area of remote operation and robotics. These techniques, now being developed, will be indispensable for intervening at different stages of the functioning of nuclear power plants as well as at the stage of irradiated fuel reprocessing for the purpose of carrying out installation maintenance. Thus, the MA 23 (fig. 4), a submersible developed in collaboration with the National Navy to man an intervention device in deep water, "ERIC II," is to be followed by five models of the MA 23-M (M for maintenance) which are intended, among other purposes, for use at the irradiated fuel reprocessing plant at La Hague for the purpose of dismantling Elan II B, which has been shut down for several years (see fig. 11).

The device "Merit" (Module for Entry, Repair, and Inspection of Exchanger Piping) (fig. 5), which has just been "inactively" tested in a section under construction of Saint-Laurent-des-Eaux, is to be operational in a year or two. It was decided to retain the design principles of this apparatus--the principal means of inspecting the primary circuits of reactors using ordinary water--for use in designing a weld-inspection device for the vessels of the breeder reactor Superphoenix.

Remote Handlers

The first "master-slave" handler possessed, from the beginning, the characteristics of those which followed: the operator holding the handle sees and directly feels the pincer reproduce the movements of his hand. This reproduction is achieved through transmissions by cables over pulleys, a system which allows the parallel transmission of independent movements, with very weak secondary friction, a limited inertia, and a certain flexibility. This flexibility does not reduce the dexterity of the handlers, which are capable of doing a job in about six times the amount of time required by direct manual work. For the manipulation of radioactive objects of significant mass, in shielded enclosures, there have been developed, coincidently with the "master-slaves," motor-driven handlers constructed according to the classic mechanics of leverage.

First Generation Programmed Handlers

These first programmed handlers, as well as most of those which followed, are based on a construction technique close to the machine tool.

The form of most of the recent models is that of an articulated arm. For certain models (only a few), the form involves a Cartesian coordinate system consisting of a rolling bridge and a verticle telescopic tube.

Among the factors influencing the form, particularly noteworthy is the integration of the handler with its work station. This factor justifies the forms based on polar coordinates, which allow, by vertical axis rotation, the transporting of objects from one point to another at the best speed, for the supply of the machines.

Another effect of the form can be seen in the choice, or the refusal, of modular construction, which was a subject of study for two machines, Versatran and Electrolux (Sweden).

At the other extreme Unimate was created based on the principle of an integrated, indivisible machine. These options involve mechanical designs which are completely different. Although it is easier to adapt a modular machine to each particular case, it is, on the other hand, easier to create an integrated machine which is harmoniously conceived.

Servo-Controlled Remote Handlers

Servo-control allows the distant reproduction of different movements. The use of servo-controls makes it possible to utilize separately the relationship of volumes covered and that of the energy expended.

Thus, with "Andromat," the operator, behind a protective window, grasps a handle whose movements will be directly reproduced by the arm, but the space is amplified by a linear factor of eight, and the energy expended by a factor of about a hundred, and the latter in a reversible manner with feedback.

This "heavy-weight" manipulator (CSEE) is used in the industrial remote control of heavy loads, particularly for the forge.

The first manipulators with bilateral electric servo-controls, created by the AEC and la Calhene, equip "Virgule." These manipulators are commanded by master-arms which look the same but which have their power reduced by a factor of three. They were followed by the MA 23 family, which is currently entering the industrial stage.

The MA 23-M, of which the first four units will be terminated in March 1981, took into consideration all the tests carried out for endurance, maintenance, versatility (fig. 10), including use in forging, welding, cutting, dismantling.

The first application will be the dismantling of Elan II B, a production shop for radioactive Cesium made from concentrated solutions of fission products from La Hague.

The device known as Piade (Intervention Apparatus Carrier Adapted to Dismantling, currently being developed) (fig. 11) will finish its trials in the fall of 1981.

Robot Vehicles

The devices Merit (fig. 5) and MIR (Inspection Machine for Rapids), which are intended to penetrate inaccessible areas of power plants, require mechanical

innovations easily as great as those required for manipulators. The sensors necessary for their guidance and operation also pose new problems. In this new technology, the essential problems lie in the integration of mechanical techniques, sensors, automation, and information systems. Because of this diversity of disciplines, robotics is, pre-eminently, a multidisciplinary and innovative activity.

Robotics and Advanced Remote Operation

Computer assistance (fig. 1) will lighten the burden of the operator and offers the growing possibility of autonomous devices. In advanced robotics, the most important acquisition, currently in progress, is the "vision" given to the systems through the television technique of image enhancement. The LETI[1] is at present one of the best laboratories on this subject.

The French efforts of LAM[2], of LAAS[3], and of the SPARTACUS project[4] have contributed to the achievement of significant progress in robotics.

Consequently, one can foresee the possibility of commanding manipulation groups by more and more synthesized orders: the command computer then takes into account a great number of reflex actions utilizing information from feedback, touch, and then vision.

For numerous functions, proximity sensors offer very promising possibilities (automatic seizing of objects, avoidance of obstacles, etc.).

In advanced remote operation, sensors and computers will produce for the operator synthesized presentations of the varied information which he must receive. The important role played by the use of television has currently led to numerous works and corresponding biotechnological studies. These works have a particular bearing on the development, with the MA 23-M and its carriers, of maintenance techniques in future retreatment plants. These works are promoted and monitored by the Department of Industrial Prototypes at Marcoule in collaboration with our branch.

In the framework of a national program of "robotics and advanced automation" assigned by the DGRST [General Delegation for Scientific and Technical Research] to the CNRS [National Center for Scientific Research], advanced remote operation is directed by the AEC and monitored by the IFP [French Petroleum Institute] and the CNES [National Center for Space Studies] in order to advance this technique for the similar needs of the nuclear and undersea petroleum industries and, in the future, of the space industry.

Conclusion

The prospects for nuclear robotics are somewhat different from those of industrial robotics. If there is a role for nuclear industry robots in the production and handling of fuel, there is also a place for them in retreatment.

Advanced remote operation, for its part, must win the race for the maintenance of nuclear generators, offering, first and foremost, an economical solution to the problem of reducing the exposure of personnel engaged in inspections, minor repairs,

later major repairs, and finally in dismantling. For retreatment, remote operation offers for the plants of the near future the possibility of carrying out machinery maintenance, and will make possible a positive trend in the amount of free time made possible. Of course, this advent of robotics in the nuclear industry presupposes a parallel evolution in the general concept of new installations in order to achieve a harmonious expansion. At the present stage, these nuclear "robots" are very dependent on the already constructed installations in which they must operate.

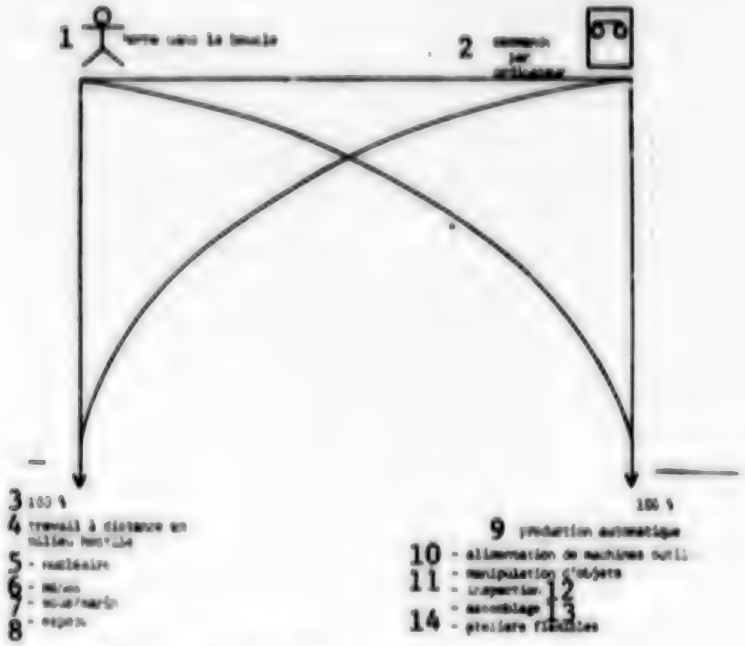


Fig. 1. — **Spectre des systèmes de commande.**

1. man in the loop
2. command by computer
3. 100 percent
4. remote work in hostile environment
5. - nuclear
6. - mines
7. - undersea
8. - space
9. automatic production
10. - supply of machine tools
11. - manipulation of objects
12. - inspection
13. - assembly
14. - flexible workshops
15. (according to the National Bureau of Standards)
16. Diagram of command system

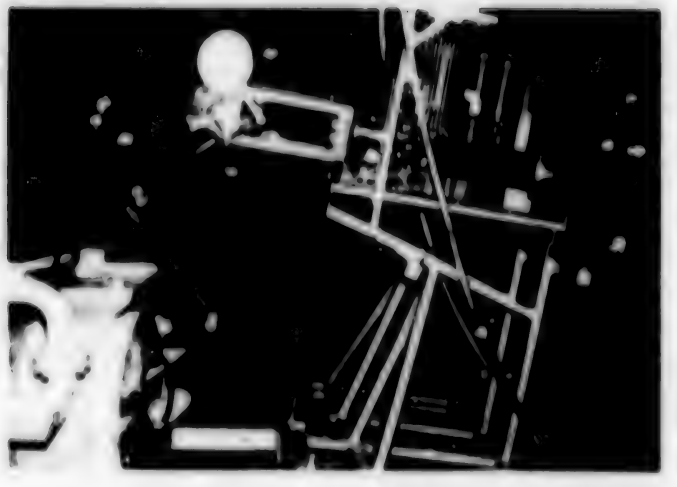


Fig. 4 - Remote control device MA 23 6000 with servo-control and feedback capable of working at depths of up to 6000 meters. Here, work on a model (la Calhene company, AEC, DTCN (Technical Directorate for Naval Construction)).

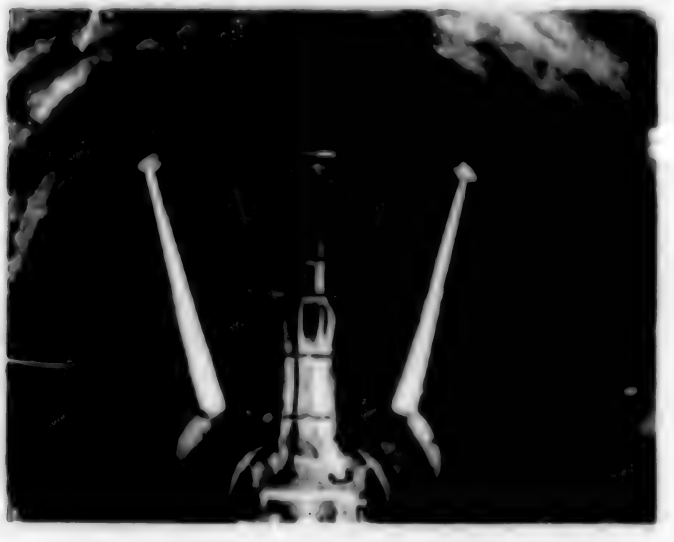
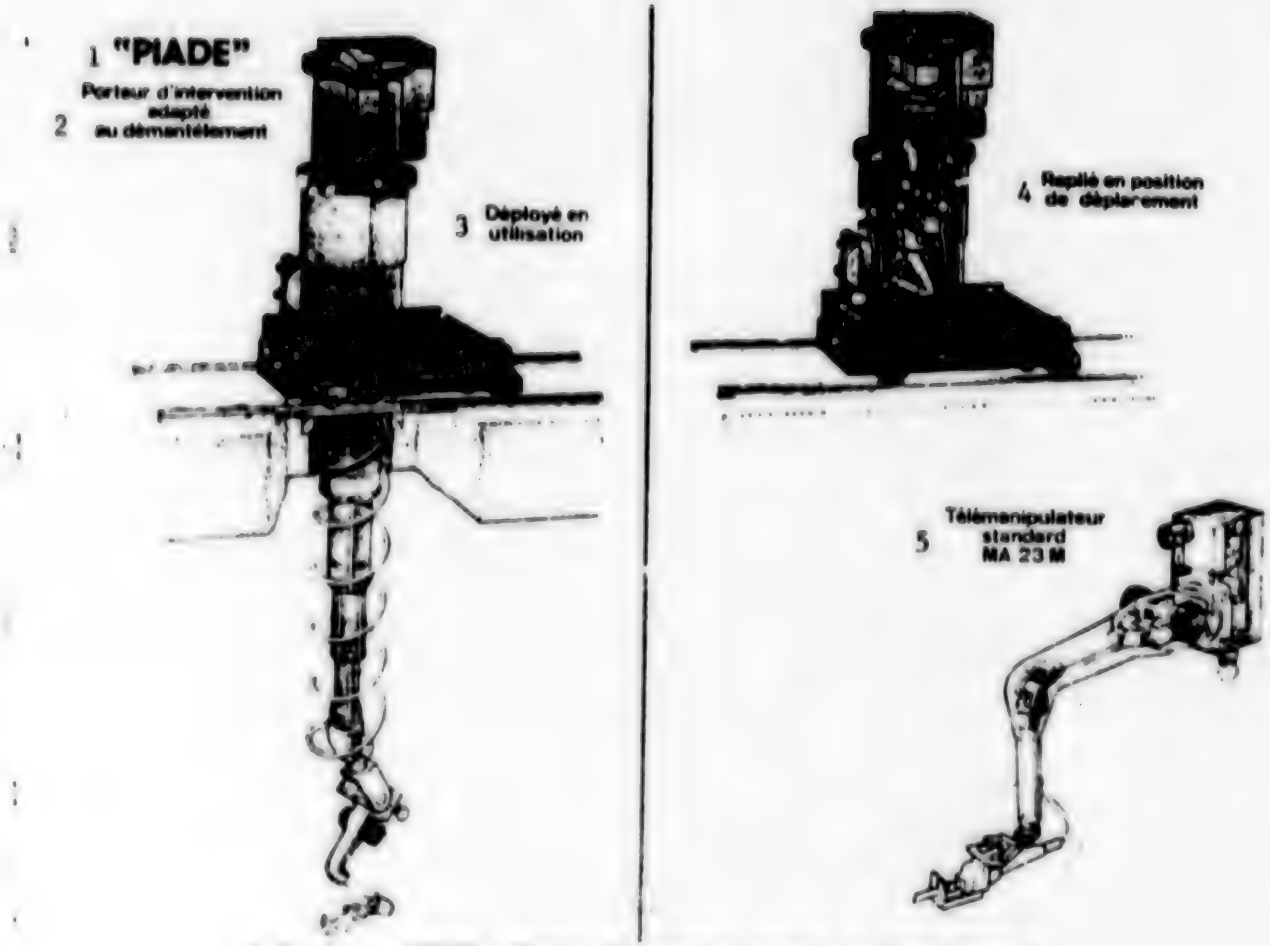


Fig. 5. - Merit Vehicle in the primary circuit of a generator being constructed. The four support arms penetrate on wheels (situated below the vehicle chassis and not visible); the pressure allows circulation in any position. Merit here descends from the steam generator toward the vat (hot branch).

Fig. 10. - MA 23 prototype, being tested, is carried by a heavy manipulator ACB (see Fig. 7). A single operator with television was able to demount the blade (below left), move it by the transfer device (background), and replace it in a period of time nine times greater than by direct operation. As a result of this test, in the future the time will be reduced to a factor of six by a more sophisticated command apparatus. (MA 23, la Calhene, AEC license).



6 Fig 11 — « PIADE », Porteur d'intervention adapté au démantèlement.

1. "PIADE"
2. Intervention apparatus Carrier Adapted to Dismantling
3. Extended in use
4. Withdrawn in place for repositioning
5. Standard remote control device MA 23 M
6. Fig. 11 - "PIADE". Intervention Apparatus Carrier Adapted to Dismantling.

FOOTNOTES

1. LETI, Laboratory for Electronics and Information Systems Technologies.

2. LAM, Automation Laboratory of Montpellier.

3. LAAS, Laboratory for Automation and Systems Analysis.

4. Project SPARTACUS was a national pilot project focused on aid to the handicapped. For five years it utilized the services of several French robotics laboratories. This project terminated at the end of 1980.

9816
CSO: 3102/351

SWEDISH APPROACH TO ROBOTIZATION REVIEWED

Paris L'USINE NOUVELLE in French 14 May 81 pp 108-109

[Article by Michel Pinto: "Robotics: the Swedish Way"]

[Text] With its powerful and well-equipped robot manufacturing firms, Sweden holds a leading position in the per capita number of robots produced and installed. All of these assets will be discussed at length on 15 May during the seminar sponsored by the Swedish Chamber of Commerce in France. But actually who are these Swedish robot manufacturers and users?

The introduction and development of robotics have tremendously transformed Western industry over the past few years. Manufacturers in all industrial sectors have finally recognized the possibilities of automation. Market research analysts all concur in predicting a veritable explosion of the robot market between now and 1990. For example, Frost and Sullivan Inc., an American management consulting and market research firm, estimates the production of robots will reach about 5,000 units by 1983, 10,000 by 1986, and 30,000 by 1990.

Japan is already firmly established in the market and will naturally strive to retain or even increase the lead. The major multinational corporations are also preparing to expand their activity in this field. Others such as Digital, IBM, and Texas Instruments are weighing the advisability of entering the market.

There is one country which launched into robotics with a few firms a relatively long time ago. That country is Sweden, and its three firms are ASEA, Atlas Copco, and Kaufeldt. Three firms, and not four since ASEA took over control of the Electrolux robot division a few days ago. Sweden is currently the leader not only in the per capita number of robots installed--a good gauge of the country's degree of "robotization"--but also in the per capita number produced. The three Swedish firms are expected to manufacture nearly 800 of the 3,000 robots Western industry is preparing to produce in 1981.

One of the reasons which account for this level of development is obviously economic in nature. Sweden had to retain a high level of productivity in order to remain competitive at a time when its wage costs were--and still are--among the highest in the world. But Sweden's installation of industrial robots was prompted by other considerations, particularly by a desire to improve working conditions and convert the more arduous manual tasks into automated systems. As explained by M. Teikman, the scientific adviser at the Swedish Embassy in Paris: "Labor unions supported automatization with robots because they viewed it as a way of avoiding the more repetitive tasks and those that generate noise or pollution."

Sweden thus launched into robotics nearly 10 years ago with the government greatly contributing to the development of this sector. The STU--an agency with functions similar to those of [France's] ANVAR [National Agency for the Enhancement of Research] and DGRST [General Delegation for Scientific and Technical Research]--participated, as part of a general investment assistance program, in financing the purchase of robots by PME [Small and Medium-Size Businesses] and in research on the integration of robots into the production process. Since 1972, more than 1,000 persons have attended training courses in robotic technology.

There is no doubt that the use of robots in Sweden will increase in the next several years through a wider distribution of equipment. By 1985, there will be 3,500 robots at work throughout Sweden. Furthermore, robots are fully compatible with the peculiar needs of Swedish industry which is composed of small mechanical engineering subcontractors for such large firms as Volvo or Scania. The fact that robots can be appropriately reprogrammed permits economical small-lot manufacturing of items differing in design only slightly one from the other.

ASEA is unquestionably Sweden's largest manufacturer of robots. It produces some 500 units per year for an annual volume of business of about 200 million francs. There are several reasons for ASEA's lead in robotic technology. This firm has been manufacturing robots for more than 10 years, robots which it first tested in its own plants before beginning to market them in 1974. In addition, the advanced technology and quality of the equipment have certainly contributed to the sector's growth.

ASEA's largest export markets are the Federal Republic of Germany and the United States. It recently opened a service center in Detroit to better service its customers which include auto manufacturers. Its estimated share of the West European market is 16 percent and of the U.S. market 5 percent. ASEA has not overlooked France, however, Jean-Francois Quinet, ASEA France's representative for automation systems, told us: "We consider France to be a most attractive potential market. That is why we have established a demonstration laboratory and have decided to give programming courses."

ASEA's line consists of two electric robots--one with a 6-kilogram capacity--designed mainly for welding, foundery, and cutting operations. Despite Japanese and American competition, ASEA views the future with confidence. "Our robots," said Jean-Francois Quinet, "have a degree of sophistication and an operating cost which make them most attractive." Pending the possible marketing of sensor-equipped robots, the company is endeavoring to make better use of the capabilities of its present robots and expand their applications.

By purchasing the Electrolux company's robot division, ASEA has remarkably strengthened its position. Electrolux--a manufacturer of household appliances--began in 1970 by making robots for use in its own plants. Then in 1972, this firm became the Swedish representative of the American robot manufacturer, Unimation. This arrangement has certainly been responsible for some of the large increase in Electrolux sales figures these past few years. In addition, Electrolux signed an agreement with Automatix [an American company]. Since 1970, the Electrolux robot division has produced 500 robots. Its expected 1981 output is 120 units with a volume of business of 30 million francs. Most of its production is sold in Scandinavia, England, and Italy, but thus far not in France.

Kaufeldt is a much smaller firm than ASEA. Its current annual production capacity is 100 robots. Its model is a pneumatic robot for use in the machine and plastics industries. Its markets are in the Federal Republic of Germany, Netherlands, United States, and Switzerland. It should be noted that Kaufeldt does not yet have a representative in France.

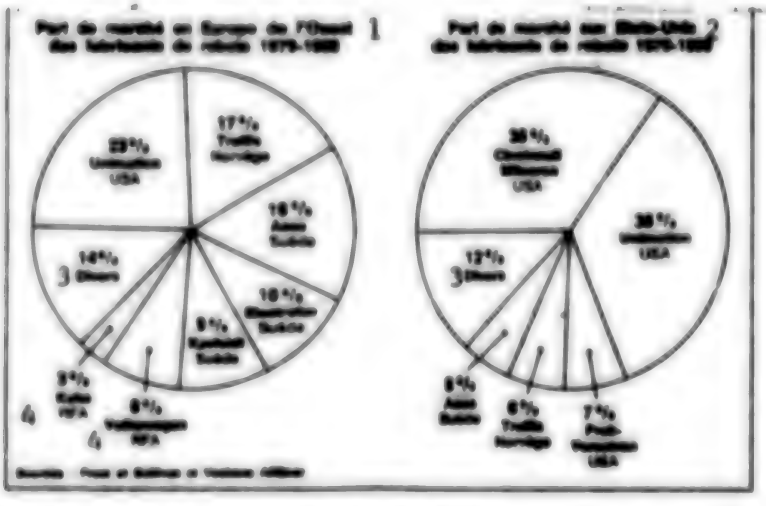
Lastly, Atlas Copco is the most recent member of the "club of Swedish robot-manufacturing companies." To complement its line of surface treatment equipment, the company has been marketing a programmable multi-axis painting robot. This robot is produced in collaboration with two other Swedish firms: Retab for the electronic part and Foco for the hydraulic part.

Increased Use of Robots by Small and Medium-Size Businesses

The projected increase in the number of robots at work in Sweden--from 1,000 in 1980 to more than 3,500 by 1985--will result from the wider and wider use of robotic technology in small and medium-size business enterprises. A certain number of small Swedish companies are already equipped with robots.

Such is the case with Magnussons, in Genarp. This firm has been operating two ASEA robots for more than 6 years. The company's managing director, Leif Johnson, claims that automatization is the only way small Swedish firms can survive.

The type of products manufactured--springs--fully warranted automatization: two types of springs, five possible sizes, in lots of 5,000 to 10,000 units. In 6 years, and with the same work force of 10 persons, Magnussons has tripled its volume of business which is currently 7.5 million kronor.



Principal European and American Manufacturers

1. Robot manufacturers' share of West European market 1979-1980
2. Robot manufacturers' share of U.S. market 1979-1980
3. Miscellaneous
4. FRG

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CURRENT STATUS OF BRITISH NC MACHINE TOOL INDUSTRY REVIEWED

Paris L'USINE NOUVELLE in French 14 May 81 pp 125-127

[Article by Patrick Piernaz: Machine-Tools: What the British Are Preparing"]

[Text] The research departments of British machine-tool makers have set themselves the goals of reducing production costs and offering more productive machines. Like their French counterparts, they presently face serious financial difficulties (during the past two years, their work force has gone from 50,000 to 45,000). But they are not throwing in the towel. This was shown during our visit to about ten British manufacturers, which revealed a good number of these new-generation machines whose marketing is either underway or about to begin after the Fourth EMO, the big Hanover exhibit.

The visitor crossing the Channel is struck by the high proportion of American company affiliates. On English soil are plants controlled by Cross International, Cincinnati, Monarch, Landis, and Warner and Swasey. But most English affiliates have a certain measure of autonomy. In particular, they have research departments which not only adapt the machines to European requirements, but study new models as well. This is the case of Landis Lund Ltd., the European division of Landis USA, one of the world leaders in mass-produced grinders.

Cameron Hill, its sales manager, points out that "although it is an American affiliate, the Keighly plant employs 50 engineers who solve problems brought by customers, and do research and development on new products. We have thus developed here in England a new computerized numerical-control (CNC) cam grinder in collaboration with the Crankfield unit of Precision Engineering." This machine solves the tricky problem of development of prototype cam contours, and is perfectly adapted to small-scale cam-shaft production. It has a span of 1250 mm between centers and uses a 3.7 kW spindle, with a 400 mm grindstone, revolving at a peripheral speed of 60 m/s.

The same policy was followed at Warner and Swasey in Halifax for the new Universal 315 lathe. John Nevins, sales manager, took care to point out that "this inclined-bed lathe was entirely designed and manufactured in Great Britain." It has a 676 mm bed clearance and a 1000 mm span between centers. It will be offered at a very competitive price (about 750,000 francs on the French market). "Our goal was to reduce our production cost. We achieved this in two ways: first, by replacing the

gear-box and its very expensive gears with a very powerful, variable speed direct current motor (44 kW), which drives the spindle with a belt. Secondly, by eliminating numerous machining operations and by revising our assembly methods."

On the Universal 315, the spindle is sealed with epoxy; there is no longer any need to ream the spindle housing. Similarly, the bed is not machined, and ground slides are added and bonded with epoxy. The whole is aligned during assembly. Consequently, many scraping and inspection operations are eliminated. The first one of these machines will be delivered to a British subcontractor employing 30 people, Craftsam Tool in Ottley. A run of 15 machines is already being built.

Dean Smith and Grace (DSG), a Monarch licensee, followed an equally original course in perfecting a lathe whose pedestal is of reinforced concrete. This research was conducted jointly with the British Cement and Concrete Association. The advantage of this solution, already successfully adopted by several European companies (G. Fischer, Muller and Pesant, Sculfort, Boehringer), is that foundations are eliminated (greatly reducing installation costs), and that vibrations are better absorbed, producing an excellent surface finish on machined parts. This universal CNC vertical-bed lathe has a 15 kW spindle and a 508 mm bed clearance. It will be equipped with an automatic dimension readout system (Renishaw), a back-rest, and a programmable tailstock, as well as an automatic parts loading device. It will be shown in Hanover, where DSG will also show the new TCI 35 lathe, a "souped-up" version of the TCI with a 26 kW motor, 508 mm bed clearance, and maximum span between centers of 1930 mm.

Still looking at lathes, the Churchill Company, which belongs to the English group Tube Investments, is currently launching a totally new model, the CTC4. It was designed for high productivity thanks to high cutting speeds and significant rigidity of the mechanical structure. This is an inclined-bed lathe with a 24 kW spindle, available in two versions: S and HS. The HS model has a dual ratio box providing a spindle speed of 4000 rpm, especially adapted for use with ceramic tools. David Wilcock, export sales manager, explained that "to assure thermal stability of the spindle, and therefore its accuracy and machining reproducibility, we opted for a Timken Hydra-rib tapered bearing mount. This equipment maintains a controlled hydraulic pre-load during the whole thermal cycle of the machine."

Another British builder, Herbert, well known in France, and which was recently in difficulty (it was picked up by the Tooling Investments group), will bring to Hanover its new line of numerical control lathes, series AL, complete with the very latest AL 10 model. Herbert's multispindle lathe section was purchased by White-BSA which has an agency in Marnaz, in Haute-Savoie (Moneo Company), and which will distribute the new 35 mm six-spindle lathe. This model can be set-up twice as fast thanks to replacement of the costly cam-drum by flat cams which are easily machined and replaced.

Wickman shows the same interest in reducing set-up times with the 200 mm diameter eight-spindle model, thanks to the use of rapid mounting tools, double indexing for machining both ends of a part, and an automatic parts loading and unloading system. Wickman also adopted an original solution to solve a fabrication cost problem. Its WT 250 CNC lathe, designed in Great Britain, is simply built in Japan!

For its part, Cincinnati, which has four plants in England, is going for a niche in the lower end of the product line market for lathe systems, with its four new Series C machines. Equipped with 22 kW spindles, the Cinturn C lathes have a 14-tool turret, and need minimal floor areas thanks to reduced structural dimensions and to integration of numerical control on the machine frame. This is a new CNC, the 900 TC Acramatic, which among other things can store different programs, cut at constant speed, and optionally, record 305 m of program.

Machining systems also are interested in reducing costs. Wadkin thus used value analysis to study the V5-10 machining system, developed from a drill-mill with a revolver turret. A 20-tool magazine has replaced an eight-tool turret. The manufacturing cost was reduced by 20 percent by eliminating hydraulic components and many mechanical parts such as gears and shafts. The spindle is directly belt-driven and its speed varies from 30 to 3600 rpm.

KTM (1000 people, 308 million francs), based in Brighton and an affiliate of the Wickers group, is setting its sights on high productivity equipment. In Hanover, it will show an 80-tool KTM 560 machining system with four worktables, providing uninterrupted machining of four different parts. Another expected new feature will be the KTM 460 equipped with a double changer of 16 multispindle heads. This equipment is intended for medium-scale production of very high productivity parts (truck and tractor parts).

J. Brest, KTM international director, explained that "we base our development policy on flexible modules. We have just delivered two four-table machining systems to the Garrett plant in Crewkerne, Somerset. This equipment will soon be linked to a PDP 11/70 computer, for direct numerical control."

This plant makes ejection systems for jettisonable airplane tanks. Each system is composed of eight different machined parts. The originality of the system delivered by KTM is that the eight parts are produced in a single fabrication cycle. Such parts are therefore no longer produced in lots with successive machining steps.

Another manufacturer, Cross International, based in Knowsley near Liverpool, has decided to take the niche between conveyors (its specialty) and the single-spindle machining system, with the Multi-Center M2. Mike Bright, general manager, says that "this equipment, already in service in two American plants, is of interest to enterprises which machine fairly large parts, with dimensions that fit in a cube of 450 to 900 mm, and manufactured at a rate of 6 to 25 per hour. For example, differential boxes, transmission boxes, cylinder blocks, and clutch housings for small-scale vehicle production."

The Multi-Center differs from a flexible shop: the parts remain fixed, and multi-spindle heads come up in sequence, along roll-conveyors, to the part being machined. Advantages, with respect to flexible shops made up of machining centers, are that floor space is reduced, and multispindle heads have higher productivity, provided however that the type of fabrication is really suited to using this system. If the

number of different parts to be handled is large, the number of stations and multiple heads has to be increased; floor coverage increases accordingly. A case-by-case comparison is necessary.

PHOTO CAPTIONS

p 125

Prototype machining system from Kearney and Trecker Marwin (KTM). At each side of spindle, note drums, which include a total of 16 multiple heads. A good compromise between the flexibility of machining centers and the productivity of conveyors.

p 126

1. Warner and Swasey Universal 315. Its price was trimmed by eliminating the gearbox, and by using epoxy for assembling, thus doing away with many machining operations.

2. CTC4 Churchill numerical-control lathe. Its spindle turns at 4000 rpm to take advantage of ceramic cutting tools.

3. Dean Smith and Grace CNC 50 lathe. Its concrete pedestal eliminates foundation costs and assures better surface finish for machined parts.

4. Landis cam-shaft grinder. Equipped with numerical control, it is suitable for small-scale production of precision parts.

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BRIEFS

FLEXIBLE PRODUCTION OF AIRCRAFT COMPONENTS—In 1983, the "Integrated Flexible Production Center of Sheet Metal Parts of the Vereinigte Flugtechnische Werke (VFW), Bremen will finally be completed; its construction is to begin shortly. The sheets grouped in packets, will be fed uder computer control to the drilling and milling unit, machined there and subsequently cleaned and deburred automatically. The small and miniature components may be identified with an optoelectronic sensor for the subsequent working processes; but this advanced technology is not yet applied, but may be used in the American aircraft industry (see report p 4). Computer control is also used in the subsequent conversion and finishing stage. The parts pass several times in some cases through the 260MN press. The necessary conversion tools are fed automatically to the press and returned to the store. The improvement of the production of sheet metal parts in aircraft manufacture is important, since these parts need, all told, the most time, even more than the parts to be machined. For example an Airbus contains more than 10,000 different sheet metal parts which make the aircraft light and elastic, but highly resistant. [Text] [Duesseldorf VDI NACHRICHTEN in German 13 Mar 81 p 1] 9018

CSO: 3102/267

CASA-NURTANIO CN-235 PROJECT IN PLANNING

Paris AVIATION MAGAZINE INTERNATIONAL in French 1 Jun 81 p 46

[Article: "CN-235: First Flight in October 1983"]

[Text] The Casa Company and the Nurtanio Company have just unveiled their plans for joint development of the CN-235 aircraft (30/40 seats) and for the terms of this collaboration. The objective of the two firms is to prepare to meet the needs of the late 1980's and the decade of the 1990's, by using the experience they acquired on the commuter market--an expanding market--through the marketing of the CASA C-212 (which the Indonesian company has been manufacturing under license for the past five years).

According to Casa and Nurtanio spokesmen, the impact of the C-212 (to-date, there are 256 orders on record from 24 countries, in addition to about 25 options) should be a strong basis for launching the new aircraft (which will be offered in passenger, mixed, and cargo configurations, both on the civilian and military market). Thus, according to Pablo de Bergia, marketing manager for Casa (8000 employees), the two companies should win 20 percent of the world civilian market for 30/40 passenger aircraft, for the 1985-1995 period; this market being estimated at 1800 aircraft, Casa and Nurtanio hope to sell about 360 planes. For the military market, estimated at 600 planes for the same period (and based on comparable capacity), the builders hope to obtain about 40 percent.

By the terms of the agreement between the two companies--an agreement which, it will be remembered, occasioned the Airtech company in Madrid as coordinator of the aircraft's design specifications and of its future production--Casa will basically manufacture the forward fuselage, the wings up to the engine, and the craft's central section; Nurtanio (3300 manpower)will provide production of wing-tips, of the second part of the fuselage, of the interior of the craft, and of the stabilizers (there will be two assembly lines operating from a single source).

Concerning marketing (the cost of the 38-seat version has been set at 3.8 million dollars), the Spanish company currently covers Europe, North and South America, while Nurtanio operates in Asia. For the rest of the world, there will be either joint or private agreements (we will not reopen the question of potential competitors for the new aircraft nor the issue of commuter market characteristics, which were amply examined in our issue No 798, p 34). Note that to face the weak financial position of commuter companies, Casa and Nurtanio plan to finance sales; however, the two manufacturers are still indefinite in this respect.

This program will cost approximately 80 million dollars, self-financed by the two companies (but it should be remembered that Nurtanio is 100 percent owned by the Indonesian government, while the Institut National de Industria holds 67 percent of Casa and is its largest shareholder).

The first flight will be in October 1983 (with one aircraft in Spain and another in Indonesia, performing this flight on the same day). Certification is expected during the latter half of 1984. The plane was designed to meet American FAR 25 and 36 certification requirements, FAR 36 pertaining to ground sound level, as well as OACI requirements, appendix 16.

The craft is a large-fuselage, high single-wing plane; it has a double-radius cross section and a three-wheel landing gear; the main gear consists of two tandem wheels that retract into lateral blisters, while the forward wheel is located in the nose of the fuselage.

The cabin is 9.35 m long, with a maximum width of 2.70 m in passenger configuration and 2.39 m of usable width in cargo version. Volume is 41.96 m^3, with an additional 7 m^3 for the rear hold area. Passenger access is through two 70 cm wide doors distributed in ribs of four (2 + 2), with 1.90 cm ceiling in the center aisle. Capacity is 34 seats for a spacing of 0.81 m and 38 seats for 76 cm spacing. In the forward cabin is a lavatory, kitchen, and closet storage.

The crew normally includes two pilots, while a third space is also provided. In the straight cargo configuration, the cabin becomes a hold, accessible through a rear undercarriage hatch; it can accommodate two P-88 containers with a 2.24 m cross section, or four LD-3's, or else 5 LD-2's, all of them standard. The cabin is airconditioned and pressurized at 3.6 PSI, according to the manufacturers.

Several military applications are planned, including transportation and dropping of loads or parachutists, as well as connecting flights.

Power is provided by two General Electric CT7-7 engines, with 1700 shaft-hp at + 15 ^{o}C ISA, both at takeoff (detuned) and in sustained maximum conditions. Specific consumption is 470 gr-hp-hr. The power is 1490 hp during climbing and maximum cruising speed (consumption, 485 gr-hp-hr) below 4570 m, and 1653 hp (consumption, 473) above that altitude.

PHOTO CAPTION

Span: 25.80 m. Length: 21.30 m. Height: 7.90 m. Wheelbase: 3.50 m. Maximum weight without fuel: 11,800 kg. Maximum payload: 4500 kg. Maximum fuel: 4000 kg. Maximum takeoff weight: 13,000 kg. Maximum allowed landing weight: 12,800 kg. Maximum cruising speed (ISA): 463 km/hr. Ascent speed (at 0 m ISA): 11 m/s. Ascent speed with one engine: 3.20 m/s. Practical ceiling: 8842 m. Ceiling with one engine: 3964 m. 10.50 m clearing at takeoff: 900 m. Landing after 15.25 m: 600 m. Range with 38 passengers: 1240 km. With 34 passengers: 1387 km. With 1130 kg load: 3700 km. Shown is an artist's conception of the craft, design based on a single structure. Profit threshold could be reached with the 360th plane.

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FIRST PRIMARY STRUCTURAL COMPONENT OF COMPOSITES FOR AIRBUS

Duesseldorf VDI NACHRICHTEN in German 2 Jan 81 p 12

[Article by D.S.: "Carbon Fibers in Aircraft Construction--The Fin Box of the Rudder Unit Is Made of Reinforced Plastic"]

[Text] Aircraft construction companies have taken up the development of a fiber-reinforced plastic rudder unit fin box for the Airbus in a research program. In 1984, a rudder unit is to be licensed by the aviation authorities and tested in airline flight operation. Environmental conditions allow for the use of resin systems having a 120°C curing temperature. A structure was chosen which is reinforced by open profiles. By use of a cost-efficient manufacturing concept, the increased cost of composite materials can be offset.

Since 1976, the Airbus-Industrie partners have made an effort to utilize modern fiber materials in the secondary structure of the A300/A310 Airbus, mainly for spoilers, landing gear flaps, floor support bars, rudders, nose gear and facings. In 1983, the nose gear and tip box lid of the rudder unit as well as the rudder will be used in series by the airlines.

While a simple material replacement by glass- and carbon-reinforced plastic (GFK/CFK) was possible for nose gear and tip boxes due to the sandwich-type construction, the rudder had to be totally redesigned. The rib-braced metal rudder is replaced by a CFK-sandwich structure without inner ribs.

In addition to an 18-percent saving in weight, the simple structure of the new rudder also allowed for a reduction of the total cost of manufacture. The resulting experience, in design, manufacture and quality assurance, with fiber-reinforced plastics, was a prerequisite for the recommendations to take up the development of the Airbus rudder unit middle box with carbon-fiber-reinforced composites within a research program.

In 1978, MBB and VFW commenced the development of the Airbus rudder unit middle box of CFK. The research program is sponsored by the Ministry for Research and Technology (BMFT). The rudder unit will be the first large fiber primary structural component for the Airbus. The component is particularly well suited to demonstrate

the suitability of modern fiber materials in civil aircraft construction. It is detachable and, due to its connection with the body structure, easily replaceable. The large structure (45 m^2 area) is characteristic for wings and rudder unit.

The development program is divided into six phases. The preparation, concept and definition phases were completed in April of 1980 with the predesign. Following the development and test phases, five middle boxes will be manufactured. In 1984 and 1986, the reliability of the CFK rudder unit is to be demonstrated in commercial flights by Lufthansa.

The Middle Box Has Five Spars

The rudder unit may be broken up into the main components of middle box, nose gear, rudder and tip box. The main dimensions are 8.3 m in height, 7.8 m in profile depth at the base, and 3.1 m profile depth at the tip. The middle box is the primary structural component of the rudder unit. The resulting rudder unit loads are introduced to the body structure by three shearing force fittings and six longitudinal force fittings. These nine fittings guarantee complete failsafe characteristics of the transition to the body. Detachable bolts guarantee the interchangeability of the rudder unit.

The middle box is equipped with three spars in the lower area and two spars in the upper area and is subdivided by framework and web plate ribs, some 500 mm apart. The aluminum planking is mechanically and chemically milled in order to vary the thickness, depending on the load that is induced; it is reinforced by Z-stringers located 115 mm apart. In the back spar, seven aluminum fittings are integrated to accommodate the rudder bearings and rudder drive cylinder. The individual structural components are connected by means of rivets and screws.

The program's success is largely dependent upon cost-efficient manufacture. Is was determined that the panels have to be designed and manufactured as integral components. Skin, stringer and rib connectors are manufactured in the autoclave in one step (one-shot curing). In order to achieve cost-efficient, "one-shot curing" panel manufacture, two concepts were developed: mat technology, and module technology.

The mat concept is suitable for the manufacture of closed stringer profiles. Shaped rubber mats stretching from rib to rib are placed on a compact bed of mats representing the basic form for ribs and stringers. Rib laminates are arranged between the mat elements, and A-profile laminates are placed directly into the bed mats. The stringer cavity is filled with a rubber hose shaped like the inner stringer surface. This lattice is then covered by the skin laminates. During the autoclave process, the pressure extends to all parts of the planking, ribs and stringers via the elastic mat and the rubber hoses. Upon completion of the autoclave process, the mats can be easily removed.

By means of the module concept, a high degree of automation is to be attained in the manufacture of stringer- and rib-reinforced light structures. In principle, light fiber structures may be realized by allocating the force flows to the structural elements as follows: planking for thrust forces, stringer and rib belts for normal forces, and stringer and rib web for thrust forces.

While all stringer belts must be one piece, the stringer webs can be cut at the cross-sections; however, thrust transmission to the subsequent webs must be guaranteed. The middle box panel is subdivided into a considerable number of small boxes formed by the stringer and rib braces. The design permits manufacture of the stringer and rib webs of such a component by simple draping of the prepeg around a rotating module core in one work step. The geometry of the resulting module is defined by the volume between two stringers and two rib clips.

Environmental factors, especially moisture and temperature, influence the strength and rigidity characteristics of fiber composite structures. The fiber composite structures must be designed for the most unfavorable conditions. These are decisively influenced by the intended use, surface lacquering, and material characteristics. Test evaluations and calculations have shown that the Airbus rudder unit is to be designed for the +90° to -70°C temperature range.

An initial prediction was made for the maximum moisture content: the long-term value will be 0.9 weight percent. As the maximum middle box temperatures do not exceed 70°C with high loads and the rudder unit structure's dimensions are mainly dependent upon rigidity requirements, a resin having a 120°C curing temperature may be used.

For fiber material fiber type KC20 according to LN29694 was chosen. It offers a good combination regarding rigidity, elasticity, costs and processability. The T300 product by Toray/Ucc fits this category. For the rudder unit manufacture the use of 8H satin webs is preferable with a weight per unit area of 400 g/m^2 and tape prepegs. Suitable resin systems are Hexcel F550, Ciba Geigy 913C, Narmco 5209, Fiberite 948 and Code 95. Hexcel F550 was chosen as the primary resin system during the definition phase.

In a few years the rudder unit with fiber-reinforced plastic is to be tested in the Airbus.

9544
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RESEARCH OPTIMIZES WHEEL-ON-RAIL TECHNOLOGY

Duesseldorf VDI-NACHRICHTEN in German 10 Apr 81 p 19

[Article by Karlheinz Althammer: "Research Optimizes Wheel-On-Rail Technology"]

[Text] Increasing demands on the track, with axle loads of up to 25 tons, require optimization of components. For the signaling system and internal operational system, conditions for the application of microelectronics in the subsystems of train guidance, train control and process control must be established. In wheel-on-rail research the interaction of vehicle and track is being studied on the test dynamometer at speeds up to 500 km/hour.

The DB [Federal German Railways] does not conduct either its own research or its own development, for that is the job of industry, the universities and special institutes. Since it is bound by Article 4 of the railway law to renew, replace and develop its property holdings, rolling stock and accessories, taking economics into consideration and in line with the most recent technology, it is carefully observing technical developments and testing to what extent they can be of service to it in fulfilling its commission under the law to provide transportation.

The introduction of three-phase rotary current technology for the propulsion of rail vehicles, for example, must be understood in the light of this premise. With this new technology, the Series 120 electric locomotive, with its 5.6 MW distributed to four axles, can be employed both for heavy freight traffic as well as for express passenger train service. The high-output electronics in this locomotive enable it to use the simple, low-maintenance rotary current asynchronous motor. Furthermore, electrical energy is fed back into the power network during breaking.

Switching With the Rotary Current Locomotive

Rotary current technology appears promising even for heat-powered locomotives, particularly for shunting purposes. This question will come up when the first diesel-hydraulic switching engines reach the end of their useful life in the next few years. As far as the track is concerned, it must be assumed that demands on it will continue to increase. Demands are being made to increase the axle loads of freight cars, in part up to 22.5 tons. Investigations are being conducted to work out the conditions under which axle loads up to 25 tons can be

permitted. Additional research must be conducted to determine to what extent the speeds of passenger trains might be increased to 250 km/hour and those of freight trains to 100 km/hour, and in exceptional cases to 120 km/hour.

In the field of signal technology, electronics were being introduced 20 years ago. The development with probably the greatest consequences was ushered in by the microcomputer, which will fundamentally alter signal technology. The use of the microcomputer in the subsystems of train guidance, train control, remote control and process control is imminent.

Besides these basic developments, some individual projects should be singled out by way of example, which, although they are of varying importance, are to be introduced gradually.

The ITS (Integrated Transport Control) is a data collection and evaluation system, with the help of which it will be possible to process all the information necessary to serve customers and to carry out internal operations by means of computers.

Mofa (Modern Ticket Sales) will expedite the more efficient and economical sale of tickets. Six thousand automatic ticket machines for local travel within a radius of 50 km, 1,000 data stations for journeys over 50 km and 2,000 ticket printing and registration machines for the sale of long-distance train tickets will be installed by 1984 at ticket windows with a low volume of traffic.

The information system "Karlchen" represents an attempt to give information about trains over the telephone using a computer. The customer dials a number from an ordinary telephone, and then a particular sequence of digits, the latter containing in code the destination, day of travel and the time. A computer voice gives the different possible routes, the time of arrival at the destination, the price and any other particulars.

Vehicle and Track Studied in the Laboratory

In the area of technology, research and development are being undertaken on basic technical questions; in the area of current projects the results derived from the technological field are tested and demonstrated; in the area of systems research, the requirements for the entire system and the subsystems are laid down and investigatory procedures are worked out to utilize technical results, with a view to their application to the transportation system.

Among the important concrete projects, work is being conducted in wheel-to-rail research with the dynamometer in Munich-Freimann, on which the interaction of vehicle and permanent way can be studied in the laboratory at speeds up to 500 km/hour; work is in progress on an experimental section for new roadbed forms on a heavily traveled stretch of track in the Munich area, using the "Vehicle-Permanent Way Test Car;," with which controlled technical investigation can be pursued.

In systems studies the cooperative Franco-German project involving railway line plans leading to a wheel-to-rail connection between Paris and Frankfurt and the

work on a model system "Freight Transport 2000" should be emphasized. The latter describes future requirements for rail freight traffic, emphasizing the calculable, guaranteed delivery of freight, the uninterrupted chain of transportation from house to house and short transportation times. In addition, the subsystem "combined load traffic" is being investigated.

9581
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SJ, VOLVO DISAGREE ON DEVELOPMENT OF HYDROSTATIC TRAIN

Stockholm NY TEKNIK in Swedish 2 Apr 81 p 3

[Article by Mikael Holmström]

> [Text] Göteborg--The tests of SJ's [Swedish Railways'] and Volvo's hydrostatic motor train are going so well that the experiments will now be expanded. Today the primary train motor is a diesel motor. SJ now wants to try electric power and would like to team up with ASEA [Swedish General Electric Corporation]. But ASEA does not believe in the project and also does not believe that any other "serious firm" is interested in getting into it.

Last week for the first time the experimental train was shown off that has now run over 2,500 km with hydrostatic transmission. The equipment was described earlier in NY TEKNIK.

SJ, Volvo Flygmotor, and the Board for Technical Development [STU] now want to go further. STU alone has invested 5.5 million kronor in the project. The tests have shown that [Volvo] Flygmotor's standard components work in the experimental train. Moreover, the microcomputer-run control system has performed its functions.

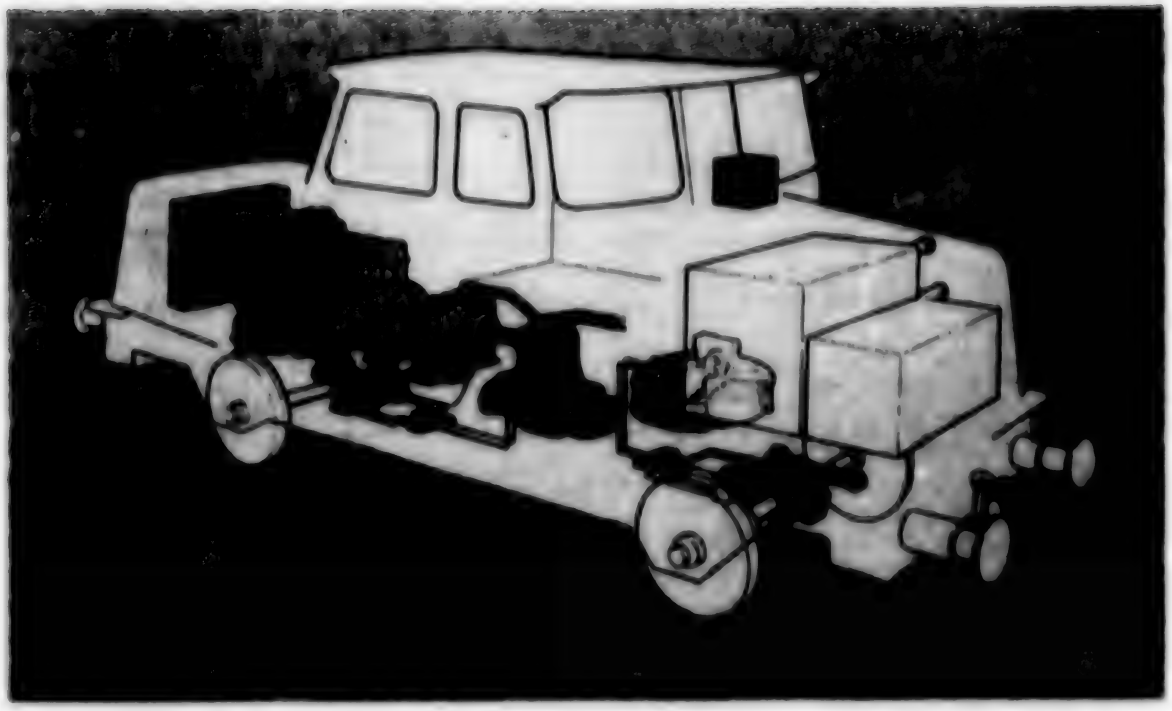
Volvo has previously pointed out advantages such as optional primary power plant at any desired place on the train, the light hydraulic motors, the possibility of placing them on any axle in the train, etc. The hydraulic motors also afford the possibility of braking directly on the driveshafts.

Light, Cheap

All in all, hydrostatic transmission would take up less space and would be lighter and cheaper than today's electrical transmission.

According to Volvo the tests show that they have largely succeeded in eliminating slippage in acceleration and locking of the wheels in braking. This is necessary if hydrostatic transmission is to be able to compete with electrical drive. It is a matter of reducing wear and tear on the wheels and avoiding the flat surfaces that would otherwise develop on the wheels from braking.

In the next stage SJ will run two switch engines hydrostatically and also continue with the present experimental train, although in a different design.



SJ is testing hydrostatic transmission. The locomotive in the sketch has diesel motor, hydraulic pumps, flywheel for energy storage, and hydraulic motors.

The primary power source in the experimental train is a diesel motor that runs at constant revolutions per minute and drives the hydraulic pumps. SJ will test motors other than diesels. For that purpose ASEA has been invited to join in. But at ASEA they are very cool toward the project.

ASEA: No

"Why should we get involved in hydrostatic transmission when we have electric feed that gives higher overall efficiency and saves energy? Hydrostatic transmission may be of interest, of course, but only for switch engines which will lie up and accumulate power for heavy work.

"Otherwise there is no need for hydrostatic transmission," they say at ASEA.

At a high level at SJ we are told:

"We want competition. If ASEA will not come in, we shall go to others and ask around. We want to support Swedish industry, but if ASEA will not come in, we shall go abroad."

Will Take 5 Years

But ASEA does not give SJ much chance of finding other electric motor manufacturers.

"For a serious firm there is no occasion to get into this--unless it is to get in on the Swedish market.

"We are not just salesmen, we are also engineers who try to be honest with our customers and not develop technology that there is no foundation for."

It may take at least 5 years before hydrostatic transmission can become a real alternative to electrical transmission. Probably longer.

On that point both SJ and ASEA are in agreement, even though perhaps they are more optimistic at Volvo Flygmotor.

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BRIEFS

FIRST FLIGHT OF SHORTS 360--Great Britain--The first flight of the Shorts 360 may take place six months early--According to a company spokesman, the aircraft's first flight, initially planned for next November, should take place at the beginning of this month (as we go to press, the Shorts company was even saying more specifically that this initial flight might occur at the end of May). However, certification of the aircraft is still expected in October 1982. It should be remembered that nine of these new aircraft have been placed on order at this date: four with Suburban Airlines, two for Chantangua, two for Alidair, and one for Ravina. [Text] [Paris AVIATION MAGAZINE INTERNATIONAL in French 1 Jun 81 pp 43-44] 11,023

HIGH-SPEED-TRAIN PROJECT PROGRESSES--The electric high-speed train TGV 016 [train a grande vitesse] of the French Railroads (SNCF) set a new world speed record of 380 km/hour at 15.57 on 26 February, at kilometer 161 near Pasilly (Yvonne) on the new Paris-Lyon line. This broke by a wide margin the world record also held until now by the SNCF. It was set, independently of each other, by the locomotives CC 7107 in March 1955 and BB 9009 on the day after at 331 km/hour. At that time both runs took place on the 1,500 volt DC electrified line between Bordeaux and Dax. The newly constructed line between Paris and Lyon is run on single-phase, 25,000 volt 50Hz AC current. For the high-speed run the overhead wire voltage was increased to 29,000 volts, the transmission ratio of the driving units was changed and the diameter of the wheels was increased by 10 cm. Additionally for the high-speed run, the train was made up of only five instead of the usual eight carriages between the driving units at each end. In every case the French record holders were standard rolling stock. A section of the new line from Paris to Lyon totaling about 60 km was selected for the record run. The actual high-speed segment started east of Tonnerre and extended about 10 km to the viaduct over the small Serein River. Many people witnessed the event here. For safety reasons, they were not allowed on the train for the record run itself, although the train had reached 372 km/hour on the previous day without any problems. After the successful high-speed run at 380 km/hour they were allowed on board and took part in a second run, during which a speed of 360 km/hour was reached. The train is said to have run more quietly at this speed than at 160 km/hour. Beginning in the fall of 1981, the TGV is scheduled to run at 260 km/hour on the completed 301 km long southern section between Saint Florentin and Sathonay. The remaining 88 km section beginning in Paris is to be ready by 1983. Not least of all, the new speed record is intended to impart to passengers on the new high-speed link the comforting feeling that the scheduled speed of 260 km/hour is completely safe and has already been surpassed by a substantial margin. [Text] [Duesseldorf VDI-NACHRICHTEN in German 10 Apr 81 p 19] 9581

THIRD BRAZILIAN AIRLINE BUYS AIRBUS--VASP is the third Brazilian airline to decide in favor of the A300 Airbus and has put in an order for three B-2 version aircraft featuring General Electric CF6-50C2 engines. The aircraft ordered by VASP are scheduled for delivery in late 1982. VASP ordered the aircraft with the new Forward Facing Crew Cockpit (FFCC). VASP, which was founded in 1923, is owned by the Brazilian state of Sao Paulo and has a fleet of 30 Boeing 727s and 737s. Utilization of the Airbus is expected to result in fuel savings of up to 30 percent. [Text] [Gelsenkirchen AEROKURIER in German Mar 81 p 260] 9544

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June 29, 1981